ENERGY

Passive Solar Subdivision Design:

A Planners' Guidebook

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September 1981

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

1. The Need for Solar Access Protection

The rapid development of solar energy for space heating and domestic hot water promises to reduce this Nation's dependence upon finite supplies of fossil based fuels. Large investments are being made in solar technologies at the local, state and Federal levels of government. But more importantly, the rising costs of fossil based fuels are triggering an even greater private investment in solar energy. Despite the growth of solar technologies and passive solar design concepts, there are some serious legal and institutional barriers impeding the rapid use of solar energy. In particular, there is no right to light law in the United States and little legal support for the use of solar energy systems at the local level of government. Recent studies by the Central Naugatuck Valley Regional Planning Agency (CNVRPA), the American Planning Association and the Environmental Law Institute[1] have emphasized the importance of developing local regulatory solutions that protect access to sunlight and permit the use of solar energy systems. Local regulatory solutions include but are not limited to amendments to zoning and subdivision regulations and the adoption of town ordinances supportive of solar energy systems.

The Central Naugatuck Valley Regional Planning Agency found that land use regulations may pose serious threats to the use of solar energy systems in two distinct ways. Land use regulations may impede or prevent the installation of solar energy systems due to restrictive standards for such items as building heights, building setbacks, fence heights, accessory use heights, floor area, lot size, ground coverage, and roof projections. Secondly, land use regulations may be inconsistent with the protection of solar access for an owner of a solar energy system.

Several years ago many, if not all, of these issues were hypothetical in nature due to the limited utilization of solar energy for space heating and domestic hot water. However, with changing oil prices and increasing use of solar energy systems, many municipalities have been confronted with requests to vary zoning regulations in order to install solar energy systems in the most advantageous positions. In addition, some municipalities have begun to realize the need for solar access policies in order to protect against possible shadows cast upon solar energy systems from construction activities on a neighbor's property.

In light of the complex land use issues raised by the rapid development of solar energy, there has been a growing need for solar access guidance to Connecticut planning and zoning commissions. This guidance has been provided by Public Act 81-334 "An Act Concerning Passive Solar Design for Subdivisions" which requires every planning commission to consider passive solar energy techniques in the design of a subdivision.[2] The Public Act states,

> The regulations shall require any person submitting a plan for a subdivision to the commission under subsection (a) of this section to demonstrate to the commission that he has considered, in developing the plan, using passive solar energy techniques which would not significantly increase the cost of the housing to the buyer after tax credits, subsidies and exemptions.

Moreover, the Public Act actually stipulates the types of passive solar energy techniques that are considered appropriate for developing a passive solar subdivision. The Act identifies five site design techniques including, but not limited to (1) house orientation; (2) street and lot layout; (3) vegetation; (4) natural and manmade topographical features; and (5) protection of solar access within the development. (see Appendix)

The State Legislature also saw fit to encourage zoning commissions to utilize incentives to stimulate the use of solar energy systems. The Public Act amended the general statutes for zoning to allow cluster development, higher density development, and performance standards for roads, sidewalks, and underground facilities to be used as incentives to encourage passive solar energy techniques.

While it may have been possible to provide incentives for the use of solar energy systems prior to the passage of this recent act, it is now a clear legislative edict.

The specific objectives of this guidebook are to:

* Explain the need for public regulation to promote the development of solar energy and protect solar access through the master plan, zoning and subdivision regulations;

* provide regulatory tools and standards for promoting the use of solar energy systems;

* identify potential policy conflicts between the development of solar energy and other land use issues; and

* present practical local experiences with the development of solar access regulations in Connecticut.

2. The Need for Public Regulations

Few people recognize solar access protection may become a serious issue as solar energy systems become more popular.[3] There are still many builders, town planners and planning and zoning commissions that do not feel promoting solar energy or protecting solar access are legitimate concerns to be addressed by a zoning or subdivision regulation. The most common objection that has been raised is that builders and developers can build solar homes and design solar subdivisions even if local zoning and subdivision regulations make no mention of solar energy systems in their regulations. The primary concern appears to be that more regulations will mean more costs to the builder, particularly builders who are not interested in constructing solar homes.

Perhaps the most convincing response to these viewpoints is that local zoning and subdivision regulations can prevent a builder from building a solar home or a developer from designing a solar subdivision. Many requirements for lot line orientation, street design, placement of street trees and protection of existing tree stands can be serious legal barriers to a solar subdivision.

Equally important is the fact that zoning regulations and other local codes (including historic district regulations, inland wetland regulations, health codes and building codes) may prohibit the use of solar energy systems under certain circumstances. The CNVRPA has identified 14 different types of zoning provisions which may prohibit the installation of solar energy systems or passive solar design concepts in residential developments.[4] In many cases, it is impossible to determine the extent to which solar energy systems will be prohibited by local codes largely because few municipalities have explicitly made reference to solar energy systems in their zoning, subdivision or historic district regulations. While the lack of specific reference to solar energy systems may or may not be a legal barrier it is definitely a perceived barrier to the use of solar energy by many homeowners. A national poll of 2,023 homeowners conducted by the Gallup Organization, Inc. during October and November 1980, revealed that codes and covenants which might prohibit solar energy systems were considered important or very important concerns by 58% of all those surveyed.[5]

Moreover, there is another reason for adopting local regulations to support the use of solar energy: there is no clear evidence that past building practices have been the most enlightened means of expediting the growth of solar energy systems and of protecting solar access. If this were the case, all of the existing solar domestic hot water systems that have been installed in Connecticut under the U.S. Department of Housing and Urban Development's $400 rebate program would be ideal examples of proper solar access protection. The facts of the matter speak for themselves. Out of 153 solar domestic hot water systems inspected in 1979, 27% of the units were shaded or were likely to be shaded in the near future.[6] In effect, past building practices are no guarantee that adequate solar access standards will be applied to future installations of solar energy systems.

Another objection raised by some builders is that the adoption of local regulations will only add to the cost of housing without guaranteeing any energy benefits to future homeowners. However, the truth of the matter is that

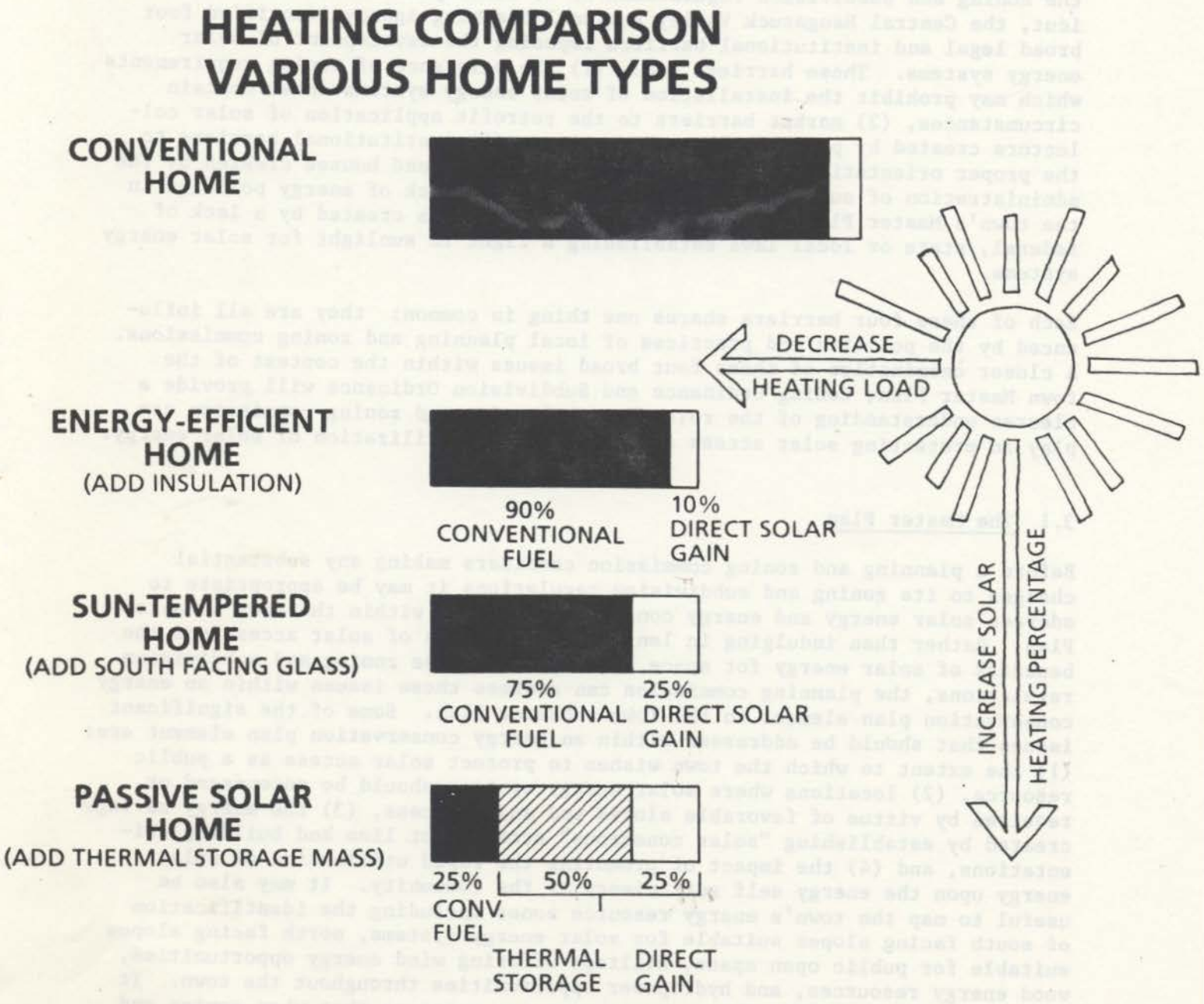
local requirements for proper house orientation can have significant energy benefits for the homeowner. A conventional home oriented with its longest axis facing south actually receives up to 14% of its energy for space heating from the sun. When that same house is well insulated and the south side of the house is provided with increased window area (double glazed), the sun can provide up to 25% of the energy for space heating. If a heat storage capacity is added to the structure, this, coupled with the large expanse of south facing windows, can provide over 50% of the home's energy for space heating.[7] (See Figure 1).

Public protection of solar access will prevent tree shadows or shadows from buildings or structures on adjoining property from reducing the efficiency of a solar energy system. Without solar access protection, a homeowner might install a solar collector only to find that a developer plans to build a tall multi-family housing project casting shadows on the collector. This problem is actually emerging in one Connecticut municipality and is likely to occur again unless solar access is protected.

Finally, there are some builders, town planners and planning and zoning commission members that believe that there is little public support for regulations encouraging or requiring the use of solar energy systems. The general perception of planners has been that any effort to promote solar access protection and the use of solar energy systems should be done cautiously. While this may be a reasonable strategy it clearly misjudges the extent to which the general public supports the use of solar energy. The 1980 Gallup Organization, Inc.'s national survey of homeowners found out a startling fact: A majority of those polled (54%) indicated that passive solar design and/or solar domestic hot water should be required by law or ordinance in new home construction.[8] The Gallup poll also revealed that of those homeowners who believe that there should be laws or ordinances requiring the use of solar energy in new home construction nearly half prefer that they be developed at the local government level rather than at the state or federal level. These findings indicate strong public support for any municipal program geared to the promotion or requirement of "solar conscious" land use planning.

Requiring protection of solar access and the establishment of proper building orientation may be initially resisted by those builders who have not yet understood the energy benefits derived from these principles. Nevertheless, the adoption of local regulations to protect solar access and promote solar energy can play an important role especially in the early stages of the development of solar energy since many builders and homeowners are making serious errors in the location and orientation of the house and in the level of solar access protection necessary for the efficient operation of the solar collectors.

Figure 1


HEATING COMPARISON
VARIOUS HOME TYPES
CONVENTIONAL HOME
DECREASE
HEATING LOAD
ENERGY-EFFICIENT HOME
(ADD INSULATION)
90% CONVENTIONAL FUEL
10% DIRECT SOLAR GAIN
SUN-TEMPERED HOME
(ADD SOUTH FACING GLASS)
75% CONVENTIONAL FUEL
25% DIRECT SOLAR GAIN
PASSIVE SOLAR HOME
(ADD THERMAL STORAGE MASS)
25% CONV. FUEL
50% THERMAL STORAGE
25% DIRECT GAIN
INCREASE SOLAR
HEATING PERCENTAGE

3. Appropriate Regulatory Techniques for Promoting the Use of Solar Energy

There are a host of land use barriers which could stand in the way of the rapid development of solar energy systems. Based on an exhaustive study of the zoning and subdivision regulations of 13 municipalities in western Connecticut, the Central Naugatuck Valley Regional Planning Agency identified four broad legal and institutional barriers impeding the development of solar energy systems. These barriers are: (1) the existence of zoning requirements which may prohibit the installation of solar energy systems under certain circumstances, (2) market barriers to the retrofit application of solar collectors created by past development patterns, (3) institutional barriers to the proper orientation of future streets, lot lines and houses created by the administration of subdivision regulations and the lack of energy policies in the town's Master Plan, and (4) solar access barriers created by a lack of federal, state or local laws establishing a right to sunlight for solar energy systems.

Each of these four barriers shares one thing in common: they are all influenced by the policies and practices of local planning and zoning commissions. A closer examination of these four broad issues within the context of the town Master Plan, Zoning Ordinance and Subdivision Ordinance will provide a clearer understanding of the role that a planning and zoning commission can play in protecting solar access and promoting the utilization of solar energy.

3.1 The Master Plan

Before a planning and zoning commission considers making any substantial changes to its zoning and subdivision regulations it may be appropriate to address solar energy and energy conservation issues within the town's Master Plan. Rather than indulging in lengthy explanations of solar access and the benefits of solar energy for space heating within the zoning and subdivision regulations, the planning commission can address these issues within an energy conservation plan element to the Town's Master Plan. Some of the significant issues that should be addressed within an energy conservation plan element are: (1) the extent to which the town wishes to protect solar access as a public resource, (2) locations where solar energy systems should be encouraged or required by virtue of favorable slopes and solar access, (3) the energy savings created by establishing "solar conscious" street, lot line and building orientations, and (4) the impact of promoting the rapid utilization of solar energy upon the energy self sufficiency of the community. It may also be useful to map the town's energy resource zones including the identification of south facing slopes suitable for solar energy systems, north facing slopes suitable for public open space, hilltops offering wind energy opportunities, wood energy resources, and hydropower opportunities throughout the town. It is important to identify these energy resource areas so that when zoning and subdivision regulations are amended there will be clear policies which ensure that the commission recognizes the energy development opportunities forfeited or created by changes to the regulations.

The Town Master Plan is also the most logical place to discuss the economics

of solar energy and the need to take a public policy in favor of the development of this energy source. In particular, the energy conservation plan element of the Town Master Plan could offer a life cycle costing analysis of solar domestic hot water systems compared to conventional fossil based fuels, as well as a life cycle costing analysis of passive solar building design concepts compared to conventional building practices prevalent within the community. It was largely due to the favorable return on investment offered by solar domestic hot water systems that San Diego County, California chose to mandate the use of solar energy for heating water in all future residential developments. A planning commission which includes an economic analysis of solar energy for domestic hot water or space heating will have a stronger basis for supporting the adoption of subdivision and zoning regulations which encourage or require solar conscious street and building orientations and adequate protection of solar access.

The planning commission may also wish to establish a goal for the utilization of solar energy by the year 2000. In 1978, President Carter established a national goal that by the year 2000 solar energy should provide at least 20% of the Nation's energy needs.[9] This goal may or may not be appropriate for any given community. In rural communities where rapid development is expected over the next 20 years, 40 to 50% of the community's energy might be provided by solar energy. In contrast, urban areas unlikely to experience much more development and having serious solar access problems may not even be able to achieve 5% of their energy needs through solar energy by the year 2000. Regardless of the actual number chosen, it is important to have some quantitative goal which can provide guidance to the planning commission in its review of future development proposals.

3.2 Zoning

Zoning is probably the most effective tool for promoting the use of solar energy systems because it can provide a comprehensive townwide or districtwide approach to the protection of solar access, the use of solar energy systems and the development of energy efficient patterns of development. No other local commission has the degree of influence over the long term energy consumption levels of its community as the zoning commission. By virtue of progressive land use policies for solar access and solar energy utilization a zoning commission can effectively expand the long term market for the use of solar energy to any degree it wishes.

In order to promote solar energy for space heating and domestic hot water purposes a zoning commission should become familiar with (1) the existing barriers to the installation of solar energy systems contained in the zoning regulation, (2) procedures for requiring or encouraging the use of solar energy systems which will assure access to sunlight over the useful life of the solar energy system, and (3) land use regulations which conserve energy thereby making it easier to use solar energy to meet a substantial fraction of a community's energy needs. These three issues should be addressed within the energy conservation plan element of the town Master Plan so that all local land use commissions are guided by a comprehensive and consistent solar energy plan for the town.

"Solar conscious" land use planning is to some degree a return to earlier principles of land planning when solar energy and other renewable energy resources played a more critical role in the location and shape of urban development. Siting houses to take advantage of the sun is certainly not a new idea. However, "solar conscious" site planning has taken on several new dimensions with the advent of zoning and subdivision regulations as land use tools for controlling the location and intensity of urban development. Today the long term opportunities for the use of solar energy are intimately related to the regulations and policies of local zoning commissions.

3.2.1 Eliminate Legal Barriers

One of the first tasks that should be undertaken by a zoning commission is the elimination of possible barriers to the installation of solar collectors. There are a variety of situations in which zoning regulations could thwart the installation of a solar collector or the design of a passive solar home. For example:

1. restrictive setbacks for rear, side and front yards could prevent a homeowner from installing a collector or attached solar greenhouse in his/her yard,

Figure 2

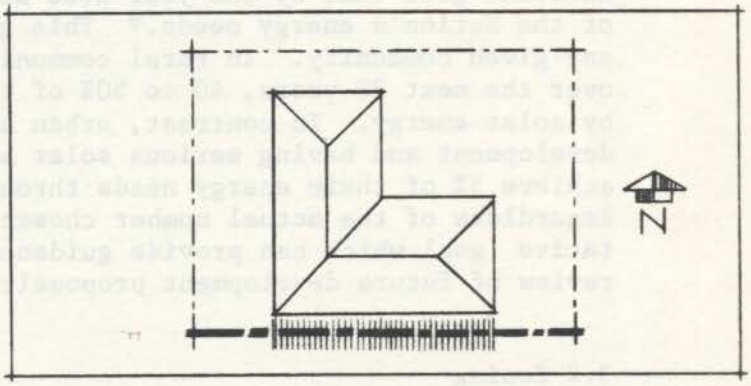
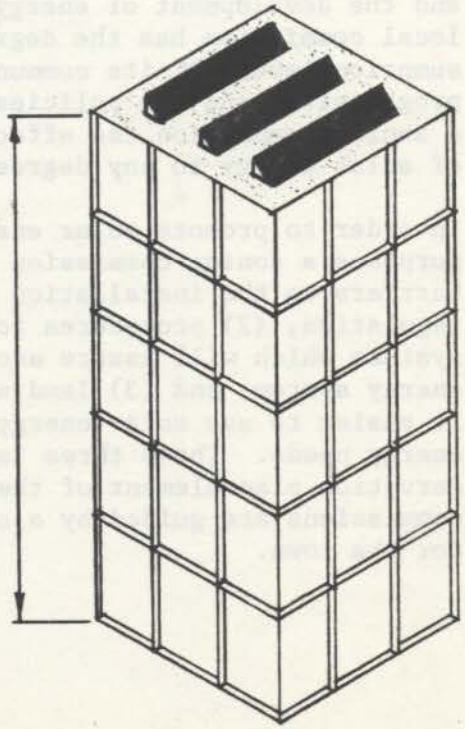
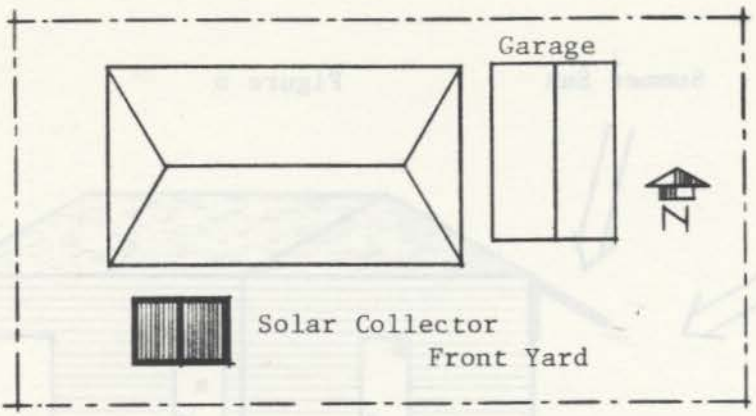


Figure 3



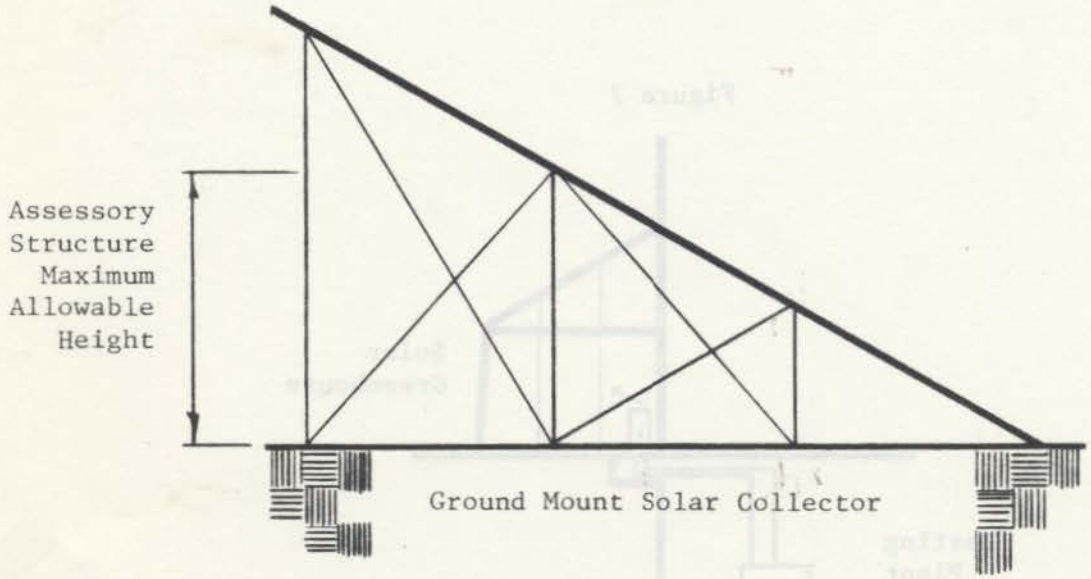
2. lack of provisions exempting solar collectors from maximum building heights could restrict rooftop installations,

Figure 4



3. accessory use regulations applied to solar collectors could prevent a homeowner from installing solar collectors in front, side or rear yard areas, (Figure 4)

Figure 5



4. regulations governing the height and maximum ground coverage of accessory structures could be applied to solar collectors thereby limiting their size and location, (Figure 5)

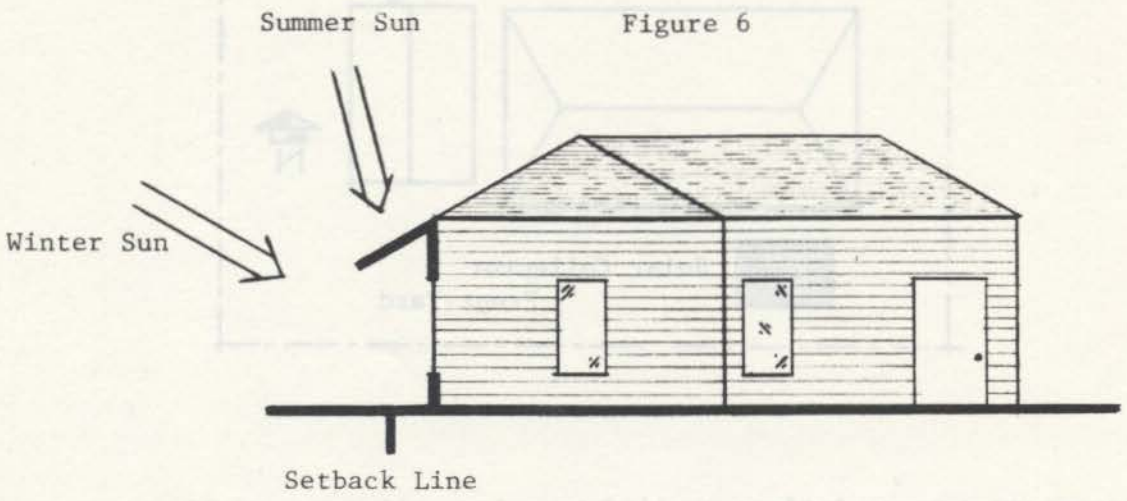
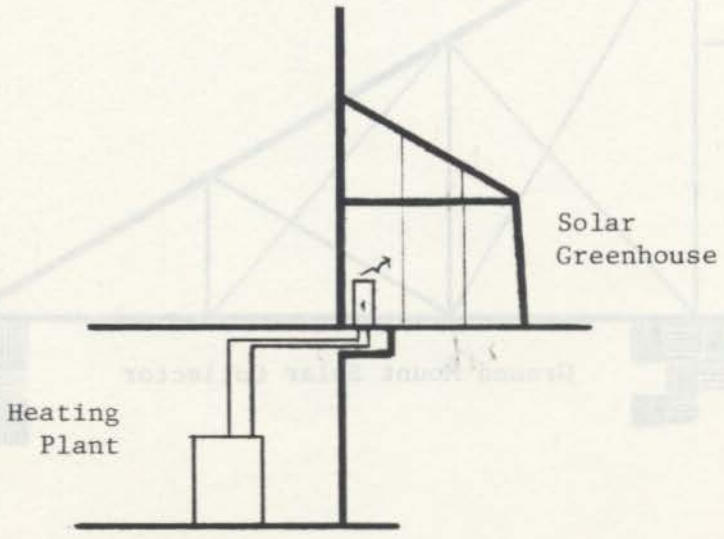


Figure 6

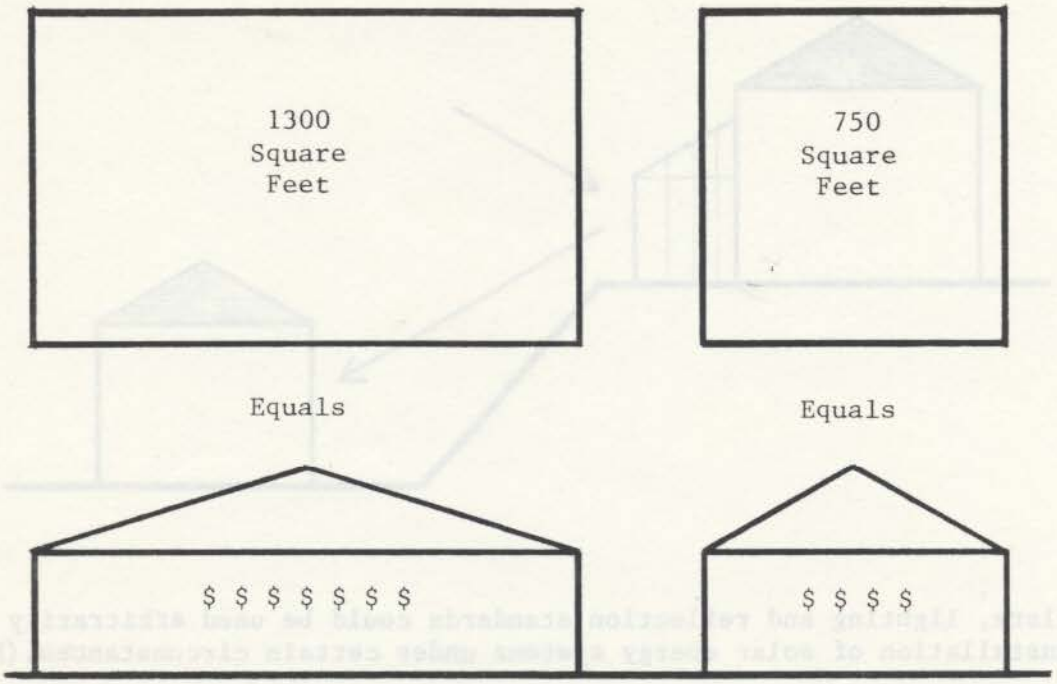
5. lack of yard projection exemptions for solar collectors or solar shading devices could interfere with the proper design of passive solar homes, (Figure 6)

Figure 7



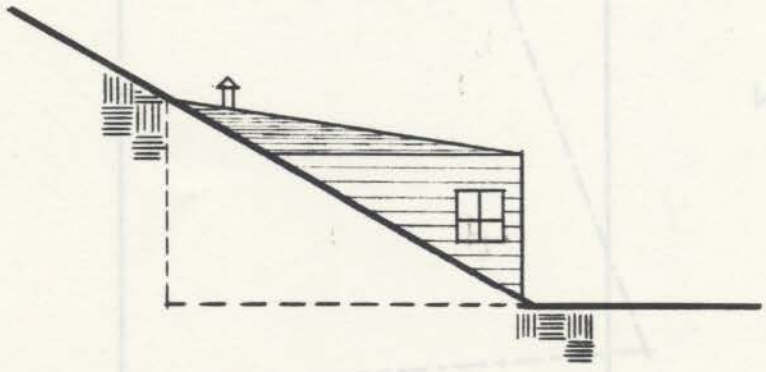
6. requiring the use of a central heating system utilizing fossil based fuels to heat all portions of a building could eliminate the energy benefits of a solar greenhouse, (Figure 7)

Figure 8



7. establishing minimum floor area requirements may unnecessarily increase the size of the house thereby increasing the cost of home heating (Figure 8)

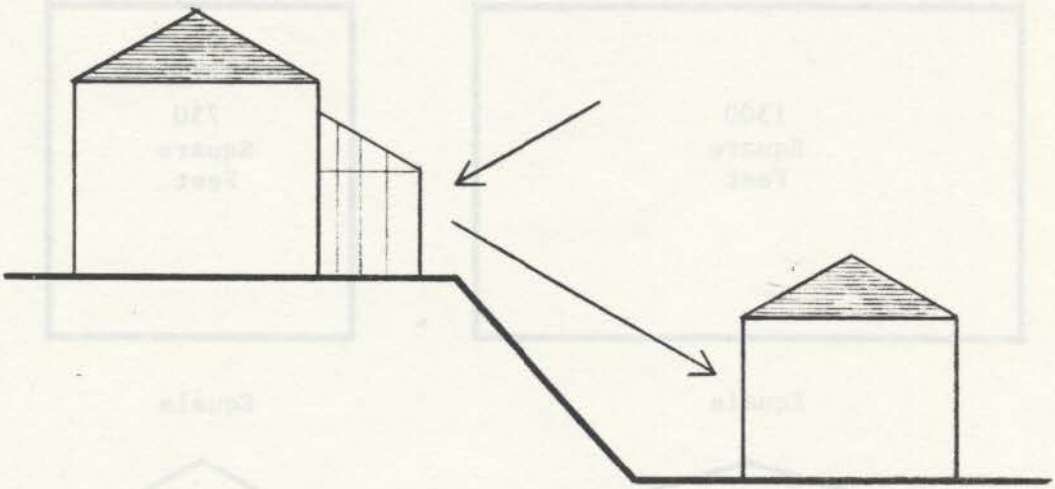
Figure 9



Earth Sheltered Home

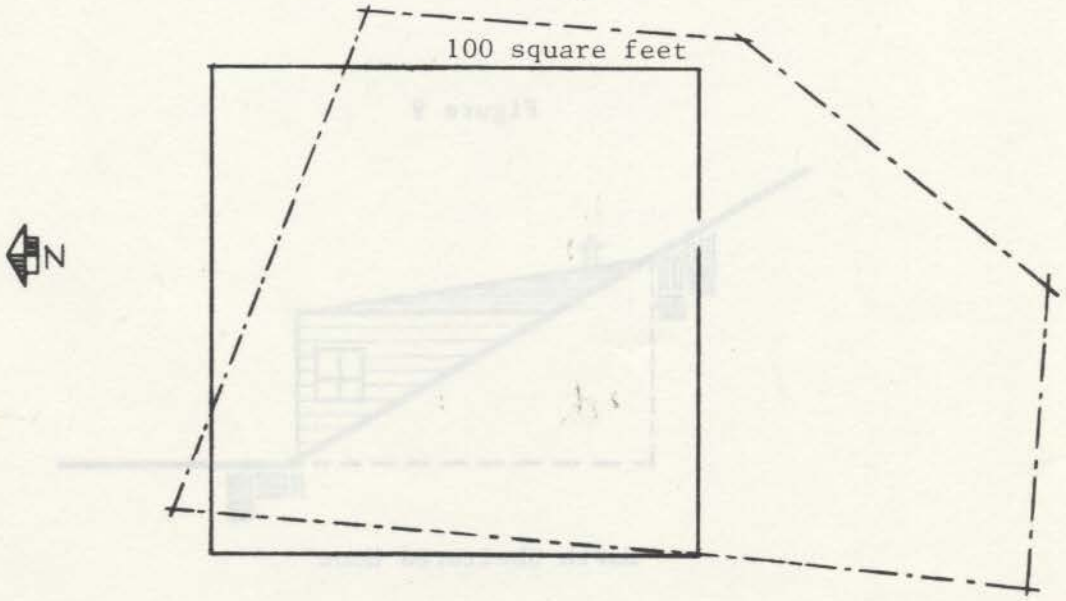
8. the existence of outdated regulations restricting the habitation of floor area located below grade could reduce opportunities for utilizing the earth for heat storage, (Figure 9)

Figure 10



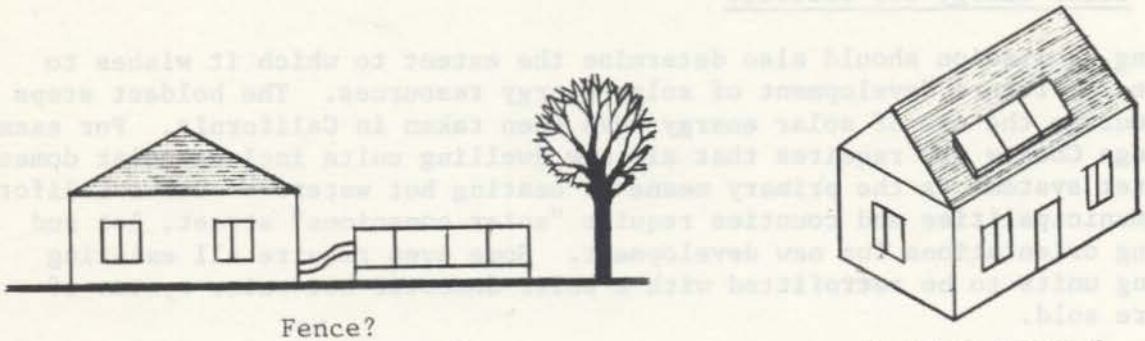
9. glare, lighting and reflection standards could be used arbitrarily to prevent the installation of solar energy systems under certain circumstances,(Figure 10)

Figure 11



10. zoning regulations that require a square of a specified dimension to fit within the lot lines may hamper flexible lot line orientations aimed at protecting solar access, (Figure 11) and

Figure 12



Fence?
Assessory Structure?

Heating System?

11. lack of definitions for solar technologies and solar access could pose problems in regulating solar energy systems. (Figure 12)

Based on nine municipalities in the United States which have adopted solar ordinances, the most frequent corrective action to eliminate legal barriers to the use of solar energy systems has involved exempting solar collectors from the maximum height limitations applied to buildings (see Appendix 1). The County of San Diego, California; Del Mar, California; Alburquerque, New Mexico; and Madison, Connecticut have all adopted amendments allowing solar collectors to be exempted from the maximum building height standards in their jurisdictions.

In contrast, the most common type of zoning variances granted to homeowners wishing to install solar energy systems, has involved a variance for solar greenhouses and solar collectors to be located in required side, rear or front yard areas. A proliferation of this type of zoning variance may suggest that zoning regulations be amended to remove legal barriers to the installation of detached solar energy systems in required side or rear yard areas.

3.2.2 Solar Energy Use District

A zoning commission should also determine the extent to which it wishes to promote the future development of solar energy resources. The boldest steps to encourage the use of solar energy have been taken in California. For example, San Diego County now requires that all new dwelling units include solar domestic hot water systems as the primary means of heating hot water.[10] Other California municipalities and counties require "solar conscious" street, lot and building orientations for new development. Some even require all existing dwelling units to be retrofitted with a solar domestic hot water system if they are sold.

A zoning regulation that requires the installation of solar energy systems for space heating or domestic hot water should be substantiated by solar access studies contained within the Energy Conservation Plan Element of the town Master Plan. This element should determine both the feasibility of using solar energy for space heating and domestic hot water and the practicality of solar energy compared to conventional fuels.

It may not be feasible in every case to mandate the use of solar energy for space heating if existing patterns of development are in conflict with the protection of solar access. For example, urban areas with high density development may find that solar applications are not feasible because of limited access to sunlight for most dwelling units.[11]

Mandating the use of solar energy may not be practical in some areas if conventional fuels are cheaper, based on a life cycle costing analysis. However, it may be possible to require solar utilization in certain sections of a town if the zoning commission determines that those areas can use solar energy at a cost cheaper than conventional fuels. Mandatory utilization of solar energy for space heating and/or domestic hot water can be achieved in varying degrees depending upon the importance a community places upon the development of its renewable energy resources.

At one extreme a zoning commission can mandate the use of solar energy in new buildings simply by requiring "solar conscious" street and building orientations. A house facing south automatically utilizes the sun for space heating to a greater extent than a comparable house facing east or west. At the other extreme, a zoning commission might require that new buildings use active or passive systems as the primary means of space heating or domestic hot water heating. The latter approach should be considered only if the commission is satisfied that such requirements are both cost-effective and feasible in terms of solar access.

In specifying areas where solar energy systems may be required, keep in mind that some locales may have poor solar access while others are ideally suited for intensive solar development. In areas where land is predominately flat or on south facing slopes the zoning commission might place more emphasis on the promotion of solar energy systems. The American Bar Foundation suggests the creation of two distinct solar energy use districts that could be superimposed on the existing land use districts of a town.[12]

1. Mandatory solar energy use districts could be established where solar access is favorable and where passive or active solar energy systems can be installed in a cost-effective manner as the primary energy source for new structures. In a mandatory solar energy use district the zoning commission would provide a greater level of solar access protection than in other areas of town through the required use of solar easements in new developments and the possible public purchase or condemnation of solar skyspace for actual, proposed or designated solar energy collectors. Mandatory solar energy use districts would be delineated based on a consideration of topography, vegetation, height, bulk and location of existing structures and the degree of solar access protection afforded by the existing zoning regulations for building heights and setbacks.

2. Discretionary solar energy use districts could be established where conditions are suitable for the use of solar energy systems but where solar access is less easily protected or where mandatory use of solar energy systems may be impractical given the topography, vegetation, height, bulk and location of existing structures and the degree of solar access protection afforded by the existing zoning regulations for building heights and setbacks. Discretionary solar use districts might not require the use of solar energy systems but could require that future roads, lots and houses be oriented in a manner consistent with the long term development of solar energy systems.

The adoption of solar energy use districts would require a thorough study of the topographic, vegetative and zoning constraints on the use of solar energy prior to the delineation of boundaries for solar energy use districts. A zoning commission should also establish a procedure for granting variances within the use districts if site specific conditions are unfavorable for the use of solar energy.

3.2.3. Density Incentives

Although a zoning commission may be legally empowered to mandate the use of solar energy under certain circumstances and in certain parts of town, it may be better to provide incentives for solar utilization rather than requiring its use. For example, density incentives offered to a developer may stimulate building activity and allow for increased solar access. The principal advantage of the incentive approach is that it offers an effective way to reduce the potential increases in housing costs that a mandatory solar energy regulation might cause.

Perhaps the most attractive incentive regulation is the cluster regulation. Cluster development allows the builder to concentrate on one portion of the tract thereby reducing the overall costs for site development and infrastructure. Applying the principles of cluster development, a planning and zoning commission can offer higher densities to a developer on one portion of the tract in exchange for retaining open space land, providing solar domestic hot water systems, and planning proper orientation and design of new dwellings

to make optimum use of passive solar energy for space heating.

Second, a floating solar zone approach could be used to provide effective incentives for the selective development of solar energy systems. Several possible criteria for evaluating the appropriateness of a floating solar zone are (1) the orientation and slope of the land, (2) the degree of vegetative cover, (3) the proximity to structures which could cast shadows upon collectors, and (4) the proposed utilization of solar energy systems in the new development. Assuming a developer is able to satisfy these criteria, he could be granted an increase in density as an incentive to make the proposed regulation financially attractive. To optimize local solar utilization a zoning commission might offer higher density development on steeply sloped land. If this were done, single family dwelling units could be located on flat land and multi family, mid-rise and high-rise structures could be located slightly higher up on south facing slopes. Such placement would reduce the shadow projection distance of these structures.

3.2.4. Energy Conservation

It is critically important to conserve existing energy resources wherever possible. This strategy does not conflict with maximizing the use of solar energy, since energy conservation and solar energy are intimately related. Properly functioning solar energy systems require special attention to energy conservation measures. A zoning commission can promote energy conservation by:

1. encouraging the use of evergreen wind breaks and earth berming on the north side of houses,

2. reducing road width standards to allow for narrower streets, thereby reducing traffic speeds and summertime heat buildup from road surfaces,

3. permitting the construction of higher density development through attached housing, common wall construction and zero lot lines in appproppriate areas,

4. reducing minimum floor area requirements for single family and multi family housing to levels consistent with the American Public Health Association Standards,

5. permitting the use of performance zoning and similar techniques that allow for more energy efficient development patterns than are normally allowed by low density suburban sprawl zoning,

6. permitting higher density development in order to create transit supporting corridors,

7. providing for neighborhood commercial facilities that reduce travel distances for convenience goods, and

8. encouraging higher density development on south facing slopes and lower density development on north facing slopes.

While changes in zoning regulations may not result in immediate reductions of local energy consumption they can have a dramatic impact upon the energy consumption levels of the community in the long run. For example, a zoning commission that implements energy conservation techniques might achieve the following energy savings:[13]

1. Reduction of minimum floor area requirements from 1300 to 750 square feet

   According to one study a 750 square foot single family detached house uses 37% less energy than a comparable 1300 square foot single family detached house. Reducing excessive minimum floor area requirements will not only reduce the cost of housing but make it easier to afford the heating bills for new homes.

2. Permitting the construction of attached single family housing as an alternative to detached single family housing

   A Tri-State Regional Planning Commission study found that on a square foot basis, attached housing used 28% less energy for space heating and other requirements than a detached unit. However, since dwellings in multi family structures are generally smaller than single family residences, energy savings are generally greater when comparisons are made on a dwelling unit basis.

3. Encouraging the use of wind breaks and earth berming in new house design

   One study revealed that an evergreen windbreak can reduce wind velocities by 50% over the prevailing wind velocities of the unimpaired wind. Less severe winds can save on fuel bills. The heating bill for an unprotected house with a 20 mph wind is approximately 2.4 times as great as that for a 5 mph wind under the same temperature conditions. In one case, reduction of wind velocities saved a protected house 22.9% in fuel over an identical house exposed to the wind when indoor temperatures were maintained at 70°F. Even greater energy savings can be achieved by building the house partially or wholly underground. Earth sheltered housing is less susceptible to high winds than above ground houses. An earth sheltered house takes considerably longer to react to outside air temperatures because earth mass is used as an insulation along the walls and on the roof of the building. One recent study found that the maximum rate of heat loss for one prototype earth sheltered house was less than 1.8°F per day, even when no allowance was made for any internal heat gain from the inhabitants. (See Figure 13)

4. Encouraging higher density development on south slopes and discouraging development on north facing slopes

   South facing slopes are an energy resource zone which should be developed judiciously so as to optimize the long term opportunities for using solar energy within the community. A south facing slope of 20% actually receives nearly twice as much solar radiation as an equivalent area of flat land on the winter solstice at 40° north latitude. Moreover, the shadow length of a ten foot pole on a 20% south facing slope

is nearly half as long as that of the same pole on flat land (see Table 1). The combination of these two factors as well as the reduced exposure to winter winds suggests that energy conservation can be promoted through higher density development on south facing slopes (see Figure 14).

Figure 13

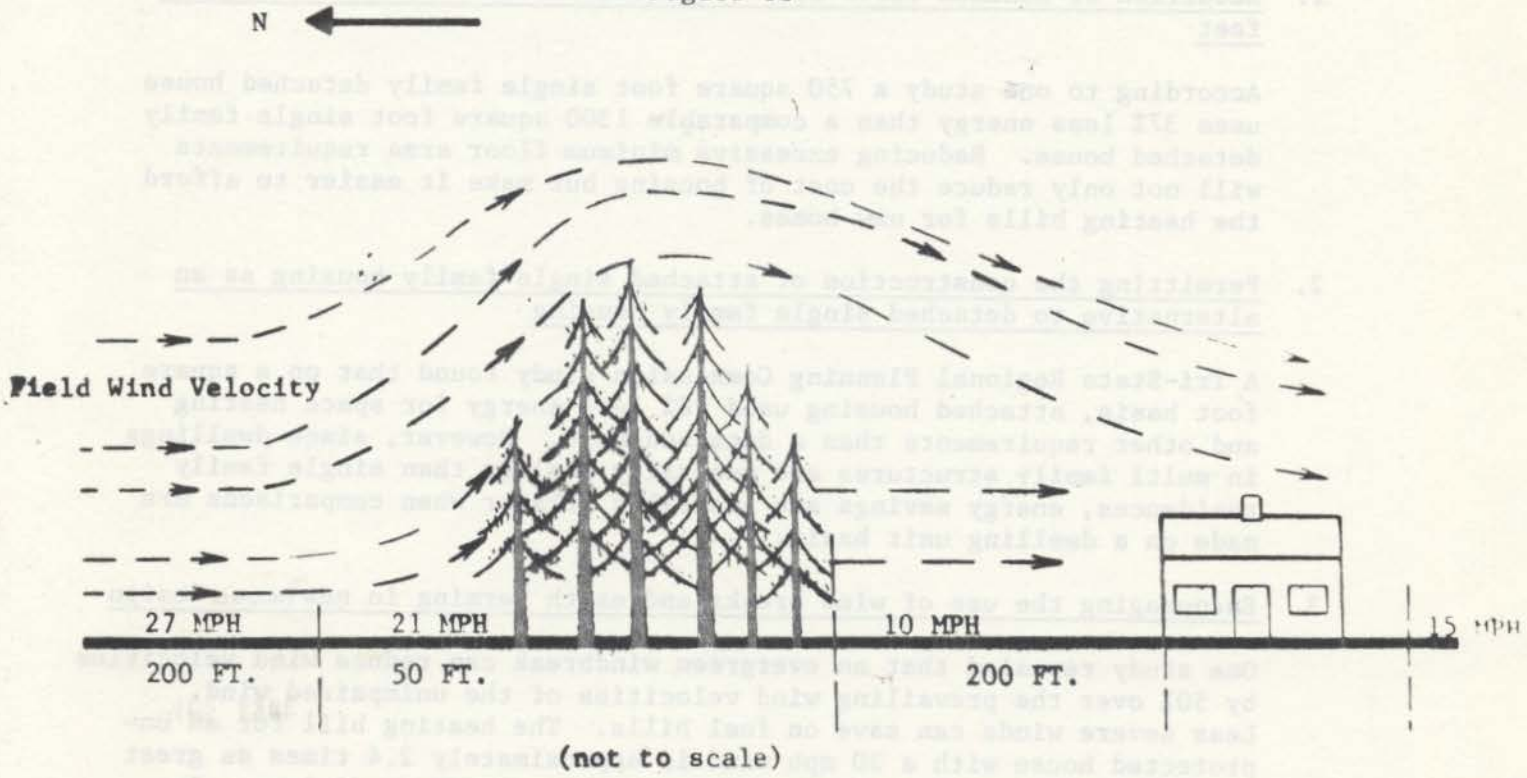


Figure 14

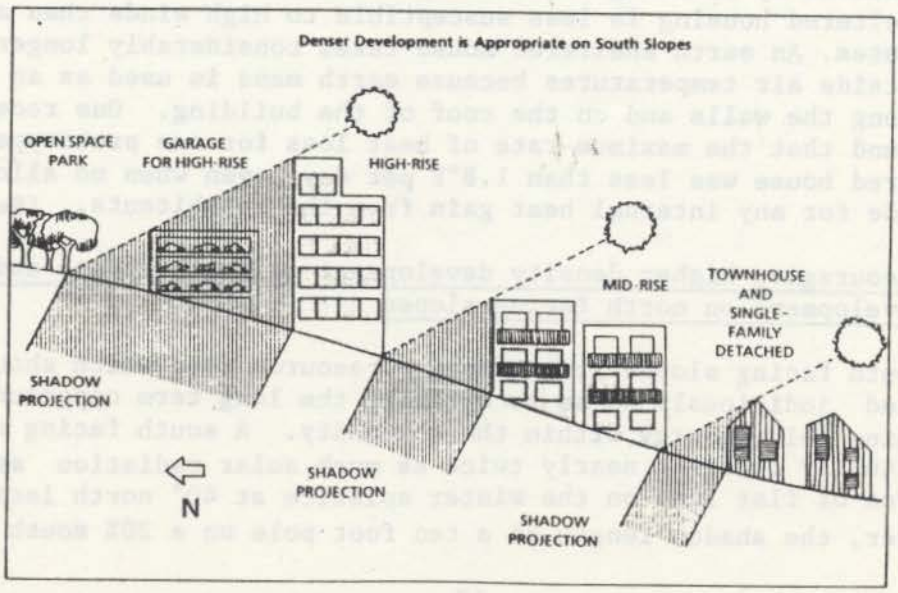


Table 1

Shadow Length of 10-Foot Tall Object and Radiation Table for 40° North Latitude at Winter Solstice

	North Face	South Face	East Face	West Face
Horizontal				
Radiation/Day	675 BTU	675 BTU	675 BTU	675 BTU
Shadow Length	20 ft.	20 ft.	20 ft.	20 ft.
10 Percent Slope				
Radiation/Day	445 BTU	897 BTU	666 BTU	666 BTU
Shadow Length	30.9 ft.	14.8 ft.	20 ft.	20 ft.
20 Percent Slope				
Radiation/Day	224 BTU	1101 BTU	637 BTU	637 BTU
Shadow Length	73.7 ft.	11.6 ft.	20 ft.	20 ft.

Source: Duncan Erley, Site Planning for Solar Access, American Planning Association, Washington, DC, 1979, p. 20.

3.3 Subdivision

The primary thrust of Public Act 81-334 is to ensure that passive solar subdivision designs are considered by any person submitting a subdivision plan so that passive solar energy systems can be used to meet some portion of the space heating and cooling needs of future residents of the state. Public Act 81-334 not only mandates planning commissions to establish passive solar subdivision design standards but it stipulates the types of subdivision standards that it must address in its regulations. In particular, the public act mandates planning commissions to create new land use controls governing the orientation of streets, lot lines and buildings since the proper administration of these new land use controls can play a critical role in promoting the use of passive solar energy systems.

However, Public Act 81-334 does not specify the extent to which a planning commission should exercise control over these issues except to say that these issues must be considered by all persons submitting a subdivision plan. A

planning commission may decide that future subdivision plans will be designed so that all lots and buildings will be properly oriented to use passive solar energy systems or it may decide that proper lot and building orientation will only be required where there is sufficient solar access to the proposed building site or lot. It will be up to each planning commission to determine what constitutes a proper consideration of passive solar energy techniques within a subdivision. Such a determination should be made after a thorough analysis has been made of the opportunities and constraints to the development of passive solar energy systems within the municipality and the impact of passive solar subdivision design upon the cost of housing.

The state legislature has made it clear that a planning commission is not to use its new land use controls in a way that would directly or indirectly increase the cost of housing to the buyer after tax credits, subsidies and exemptions. This legislative edict indicates that any passive solar subdivision design regulations that are adopted can not be used as a means to increase land, house or site development costs even if the reason for the increased costs is attributable to the development of a more viable passive solar subdivision design. Undoubtedly, new considerations such as those outlined in Public Act 81-334 will increase a developer's costs to a degree but as long as these new considerations do not result in significantly increasing the cost of housing (after tax credits, subsidies and exemptions) a planning commission will have met the intent of the legislation.

It is important to understand that the development of a passive solar subdivision design does not imply the need for lower density zoning or the elimination of urban patterns of development. Development at urban densities can effectively utilize solar energy for heating and other purposes if streets, lots and buildings are properly oriented and solar energy systems are sited in the most favorable locations for protecting solar access. With proper planning at the site and community levels, solar energy can be effectively applied to meet the needs of multi family and high rise development projects. Rather than being an excuse for reducing densities in support of exclusionary land use policies, the development of passive solar subdivision design regulations offers the challange of balancing the need for solar access protection with the pressures for vertical development in high density urban areas.

The principal advantage of incorporating solar orientation considerations into subdivision regulations is that future development can be sited in a manner consistent with the long term development of solar energy. Optimal development of solar energy depends upon the site planning practices of today's builders and developers. If buildings are not oriented properly, the future market for solar energy systems will be adversely affected. According to a

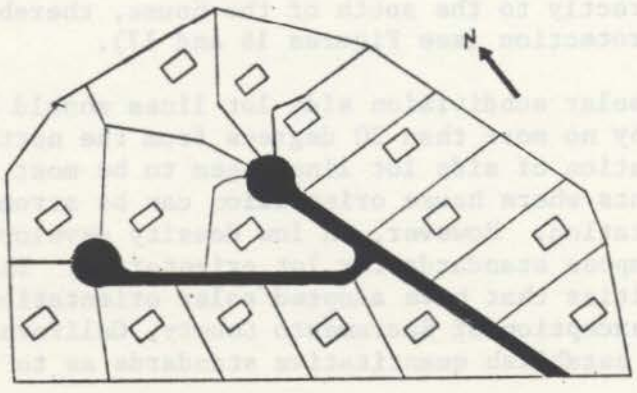
recent survey by the Central Naugatuck Valley Regional Planning Agency, past development patterns have largely overlooked solar access and solar orientation considerations. In 1970, only 11% of all building roofs in Southbury, Connecticut, 13% of those in Woodbury, Connecticut, and 26% of those in Cheshire, Connecticut were oriented within 15 degrees of true south.[14] Such development patterns have caused two interrelated problems: (1) homeowners in the future will find it difficult to use solar energy effectively because of improperly oriented roofs and south walls, and (2) when future homeowners choose to install solar energy systems, those systems will either have ground locations (where solar access is more difficult to protect) or be placed in an awkward position on improperly oriented roofs. In order to minimize aesthetically unappealing solar energy systems and to increase the extent to which future residents can choose solar options in the construction of new or retrofit projects, it is imperative to begin the solar planning process as early as possible. As of December 1980, there were fewer than twenty municipalities in the United States that had adopted solar energy amendments to their subdivision regulations (see Appendix 2). It appears that a growing number of municipalities are likely to adopt such amendments as experience is gained from the successes and failures of the first generation of solar regulations.

3.3.1 Street Orientation

One of the essential prerequisites for the effective use of solar energy systems is a southerly orientation. If a building is not oriented with its longest axis facing to the south, it may not be feasible to use the south wall of the building to collect a substantial amount of solar energy for space heating. Building orientation often depends upon street and lot line orientation, especially in higher density developments where the street orientation strongly influences the ultimate location and orientation of the building. Planning commissions traditionally have been concerned with developing street systems that tie into the existing street network and, at the same time, harmonize with the topography of the land and avoid construction upon wetlands and other unbuildable soils. In a solar subdivision these basic planning considerations must be considered. However, in addition, the orientation of the proposed street system must facilitate the subdivision of lots and the placement of houses that will have adequate access to the sun. Where practicable, planning commissions should consider street orientations that foster development of passive solar house designs. (See Figure 15).

Figure 15

A Solar Subdivision
Naugatuck, CT



Streets that are constructed along an east-west axis should have little trouble in accommodating passive solar dwelling units. On an east-west street, the longest axis of the dwelling unit is easily placed parallel to the street, thereby ensuring a conventional appearance to the overall design of the neighborhood. At the same time, this provides for optimal orientation of dwelling units to the south.

An east-west street orientation is not the only street pattern that is conducive to the development of passive solar homes. Passive solar subdivisions can be developed on north-south streets provided that development to the south does not reach the maximum level allowed by local zoning regulations. A recent study of the zoning ordinances of 13 municipalities in the Central Naugatuck Valley Region revealed that south wall solar access could not be guaranteed on north-south streets anywhere in the Region if houses were built on flatland under the worst case conditions for maximum building height and minimum setbacks allowed under the regulations.[15] However, if building heights are reduced or if development occurs on a south facing slope, south wall solar access protection is possible on a north-south street.

Establishing a street orientation standard is desirable since it can have a dramatic impact on the public acceptance of solar subdivision design. However, a mandatory street orientation standard may not be necessary for municipalities accustomed to the topographic conditions found in the northeast. Moreover, a mandatory standard might be unreasonable in light of such influences on land design as slopes, wetlands, soils, the density of development and existing street patterns. Consequently, the best approach would be to establish a street orientation standard requiring that roads be constructed along an east-west or north-south axis with acceptable deviations of 30 degrees off either axis only when there are no topographic constraints and no limitations created by the existing street system.

This type of approach provides for specific street orientation standards without unduly burdening the developer in those circumstances where street design is largely dictated by topography.

3.3.2 Lot Line Orientation

In those cases where roads cannot be properly oriented along the east-west or north-south axis, planning commissions can offer greater flexibility in the delineation of side lot lines in order to allow for the southern orientation of lots. This technique provides a greater degree of control over vegetation and objects directly to the south of the house, thereby offering greater solar access protection (see Figures 16 and 17).

Ideally, in a solar subdivision side lot lines should be parallel to true south or vary by no more than 20 degrees from the north-south axis. Standards for the orientation of side lot lines seem to be most important in higher density developments where house orientation can be strongly influenced by the lot line orientation. However, in low density developments it may not be necessary to impose standards for lot orientation. The experience gathered from municipalities that have adopted solar orientation regulations indicates that with the exception of Sacramento County, California (see Figure 18), none have chosen to establish quantitative standards as to the maximum allowable

deviation of a lot from true south. The prevailing practice among municipalities that have adopted solar orientation regulations is to provide flexibility in the delineation of lot lines to accommodate the varied topographic conditions at the site.

Figure 16

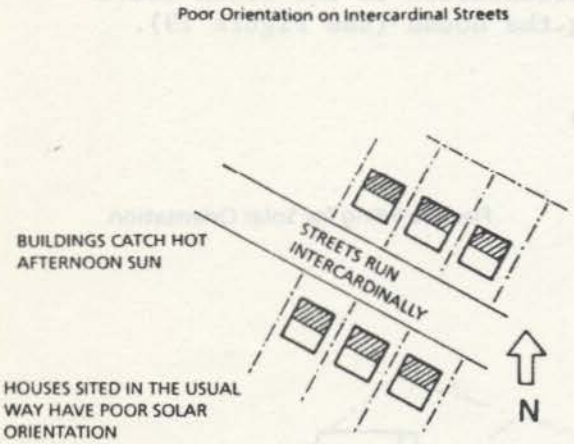


Figure 17

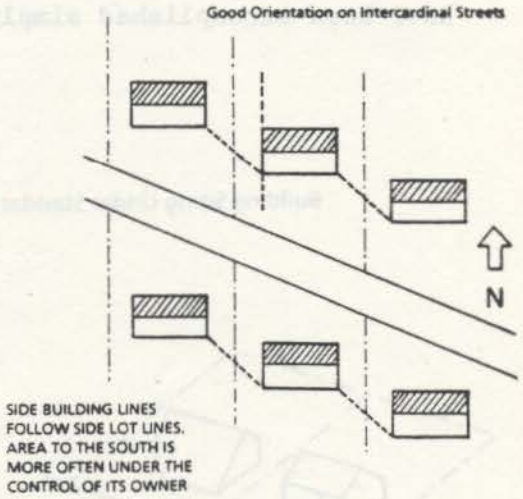
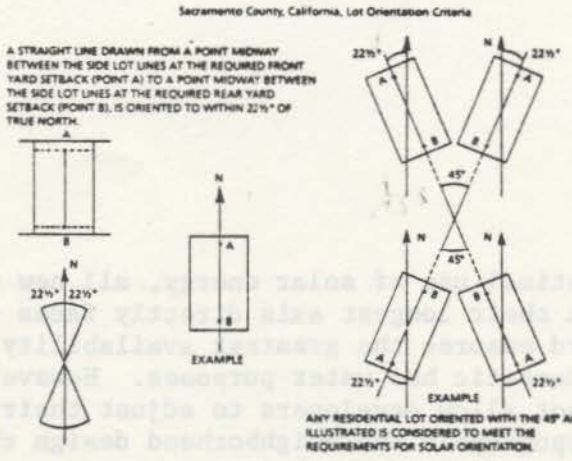


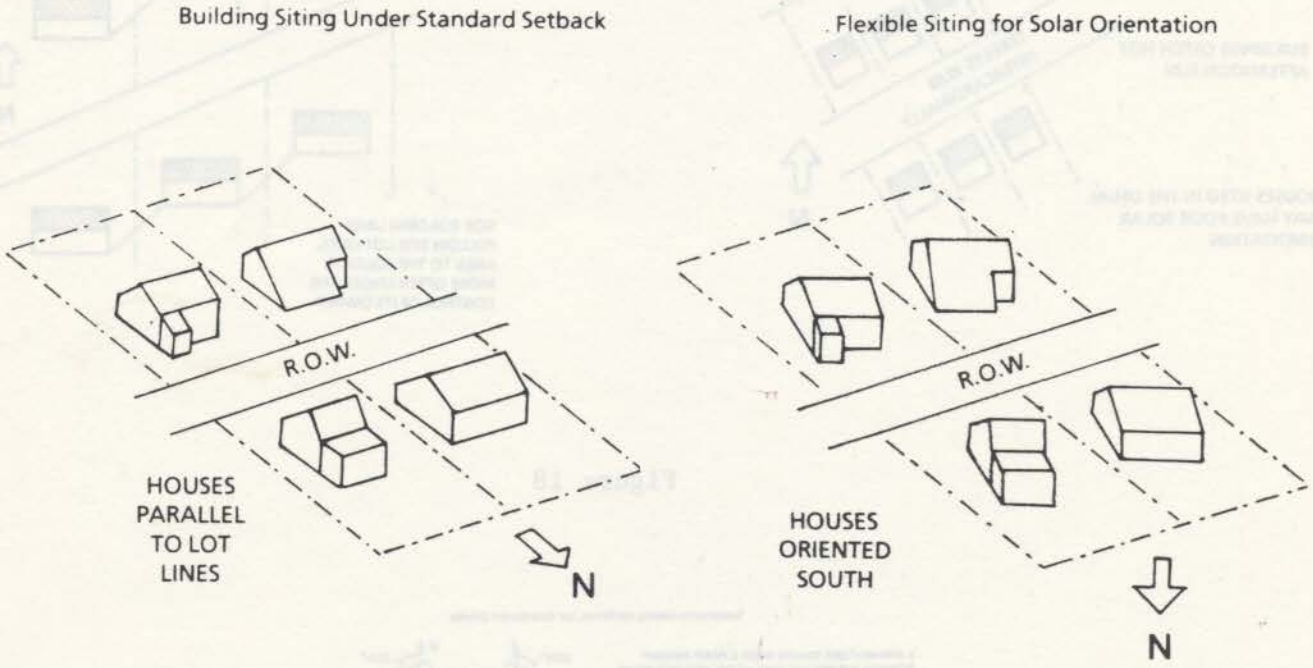
Figure 18



3.3.3 Building Orientation

While street and lot line orientations offer important tools for creating solar subdivisions, it is generally the location and orientation of the house which is the most significant factor. This is particularly true in suburban and rural municipalities where low density zoning effectively offers a great deal of flexibility in the actual orientation and location of the house within prescribed setback distances. For example, a 1980 survey of the last eight subdivisions approved by the Southbury, Connecticut Planning Commission revealed that, in all but one case, proper orientation to the south could have been accomplished simply by reorienting the house (see Figure 19).

Figure 19



To encourage the optimal use of solar energy, all new dwelling units should be oriented so that their longest axis directly faces true south. This orientation standard ensures the greatest availability of solar energy for space heating and domestic hot water purposes. However, it is entirely inflexible and does not allow developers to adjust their dwelling units to the unique climatic, topographic and neighborhood design characteristics of the proposed development. Consequently, it is necessary to allow for some flexibility in building orientations.

The principal factors that influence the selection of an appropriate building orientation standard are: (1) the percentage of solar radiation available at any given orientation off true south, (2) applicable state solar property tax exemption standards for active and passive solar collectors, (3) the proposed use of the solar collector, whether it be for space heating, domestic hot water or electrical generation, and (4) the outdoor temperature.

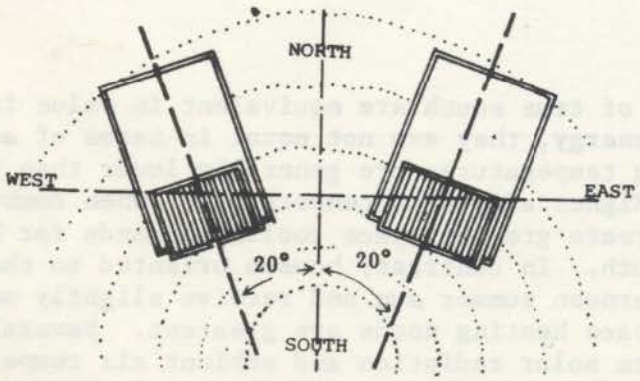
3.3.4 Orientations for Property Tax Exemptions

The first significant factor to be considered is the definition of a solar energy system eligible for property tax exemptions. The State of Connecticut provides property tax exemptions for passive and active solar collectors under Public Act 80-406 and Public Act 76-409 respectively. In order to be eligible for property tax exemptions, an active solar collector panel should be oriented within 20 degrees of true south and a passive solar collector (e.g., a south wall of a building) must be oriented within 30 degrees of true south.[16] The greater flexibility provided for passive solar energy systems largely reflects the fact that building orientations may not be as flexible as individual solar collector panels. Greater flexibility is required for passive solar collectors in order to increase the potential usefulness of the exemptions for existing homes that wish to retrofit passive solar energy concepts into the structure.

Planning and zoning commissions which intend to provide building orientation and collector orientation standards should be consistent with these property tax exemption orientation guidelines.

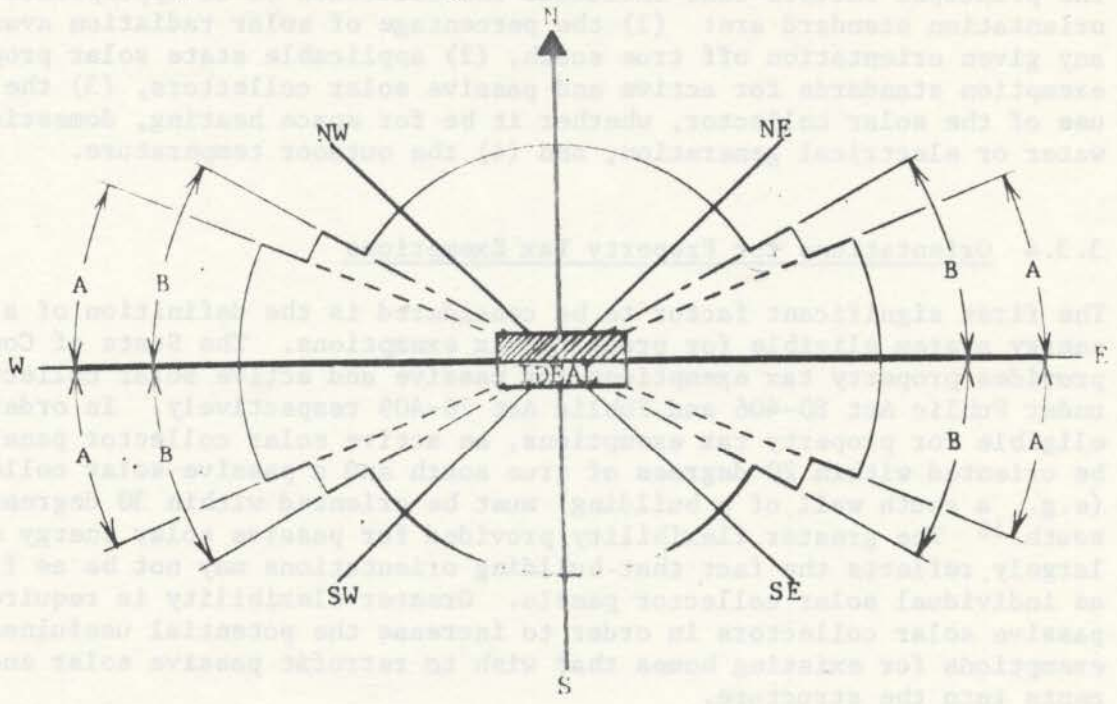
These property tax exemption orientation guidelines are generally supported by recent reports by the U.S. Department of Housing and Urban Development (HUD) and the American Planning Association. According to HUD, an active solar collector used for space heating or hot water should not deviate more than 20 degrees off true south (see Figure 20). Similarly, the American Planning Association suggests that passive solar houses should have their longest axis facing within 22.5 degrees of true south in order to have good exposure to the sun[17] (see Figure 21).

Figure 20: Active Collector Orientation Standards



COLLECTOR ORIENTATION A collector orientation of 20 degrees to either side of true South is acceptable under the State Property Tax exemption for Solar installations.

Figure 20: Building Orientation Standards



A - 22.5° American Planning Association suggested orientation
B - 30° Mandatory Orientation for Property Tax Exemption

A building which has its longest axis facing 30 degrees off true south actually receives 90% of the solar radiation received by the same building facing exactly south. A loss of 10% in solar radiation appears reasonable given the greater flexibility offered to developers siting new homes.

In the case of active solar collectors, several recent studies have found that under certain conditions for roof pitch, a collector may deviate up to 90 degrees off true south and still function at efficiencies of up to 80% of the same collector panels facing true south at latitudes as far north as Connecticut.[18] While solar collector panels oriented to the east or the west are not encouraged, it must be understood that such orientations may be feasible in certain circumstances.

3.3.5 Sol-Air Orientations

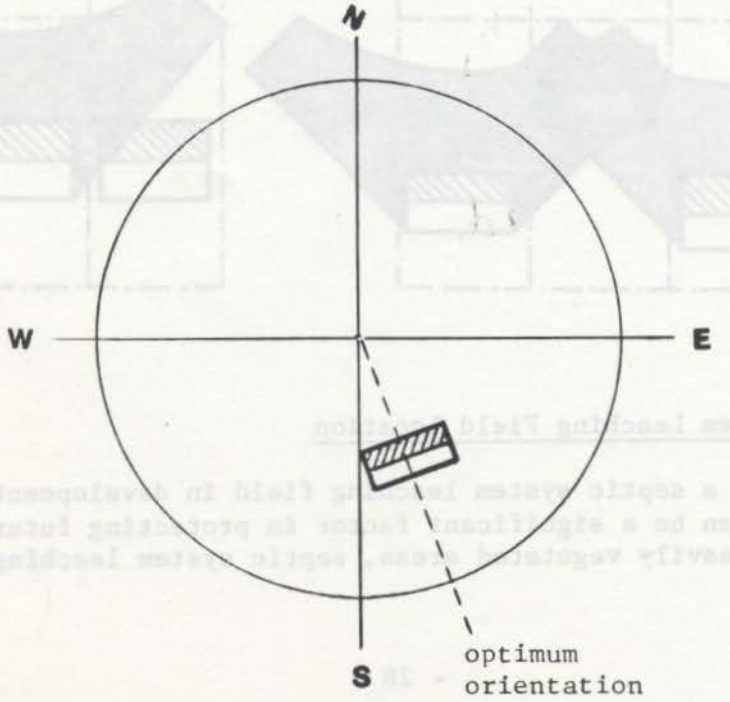
While deviations on either side of true south are equivalent in value from the standpoint of collecting solar energy, they are not equal in terms of ambient air temperatures. Early morning temperatures are generally lower than those experienced in the afternoon. Higher afternoon temperatures, when combined with solar radiation, tend to create greater space cooling demands for houses oriented to the west of true south. In contrast, houses oriented to the east of true south avoid the hot afternoon summer sun and receive slightly more early morning winter sun when space heating needs are greatest. Several municipalities have already taken solar radiation and ambient air temperatures into consideration in the formulation of what is called the sol-air orientation

standard. For example, Southbury, Connecticut and Port Arthur, Texas have both established building orientation standards which encourage new buildings to face slightly to the east of true south (see Figure 22). The overall effect of the sol-air orientation standard is to balance the need for winter space heating with the need for summer space cooling.

4. Appropriate Regulatory Techniques for Protecting Access to Sunlight

The second major issue that planning and zoning commissions must face is the protection of solar access. Promoting the use of solar energy systems may be important but such a policy will also require public support for solar access in order to guarantee the continuous usability of the solar energy systems installed. Public Act 81-334 indicates that a planning commission must address "the protection of solar access within the development". To a large degree this new responsibility will require the support of the zoning commission since many of the factors influencing the level of solar access available within a development are determined by height, area and bulk requirements contained in the zoning ordinance. Consequently, protecting solar access within a development can be facilitated by the adoption of districtwide or townwide solar access protection standards. Fortunately, Public Act 78-314 has provided Connecticut Zoning Commissions with the authority to address issues of this kind since that act specifically indicates that encouraging the use of solar and other renewable energy resources is a legitimate purpose of zoning. Since both planning and zoning commissions must play a role in the long term protection of solar access this section of the guidebook identifies solar access tools suitable for subdivision design as well as for the evaluation of solar access on a townwide basis. There are a variety of regulatory techniques that can be used to protect solar access including (1) "solar conscious" site planning, (2) solar envelope zoning, (3) zoning policies protecting solar access, and (4) subdivision policies stipulating the use of solar easements as a condition for the approval of subdivision maps.

Figure 22

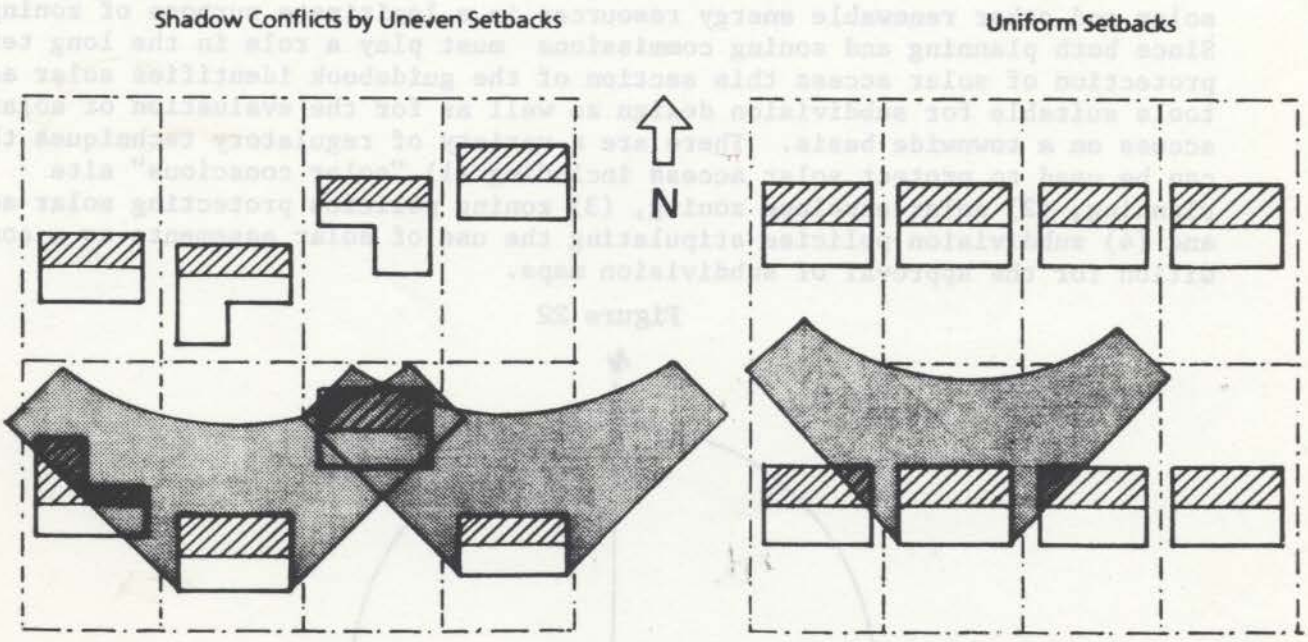


4.1 Solar Conscious Site Planning

A first step to protecting solar access is to provide for the proper location and orientation of houses in new developments. A planning commission may encourage the provision of adequate solar access to each dwelling unit by requiring developers to identify and evaluate the shadows cast by objects located within 45 degrees of the south side of the proposed building sites. The identification of solar access problem areas can ensure that shadow problems are minimized at the outset of the development.[19]

Another method of accomplishing the same objective has been to require that the south walls of buildings within a subdivision receive uninterrupted sunlight between the hours of 9:00 a.m. and 3:00 p.m. on December 21st. This approach is somewhat more flexible since it does not require the developer to map the shadows cast by objects to the south of the collector, but does require that the developer locate the building so that existing and proposed buildings and vegetation do not create any shadow projections on the collector surface. With this method, the burden would be on the developer to ensure adequate solar access. This approach would allow the developer to determine whether tree cutting, setback of houses, or a combination of these techniques would be the best means of maximizing solar access (see Figure 23).

Figure 23

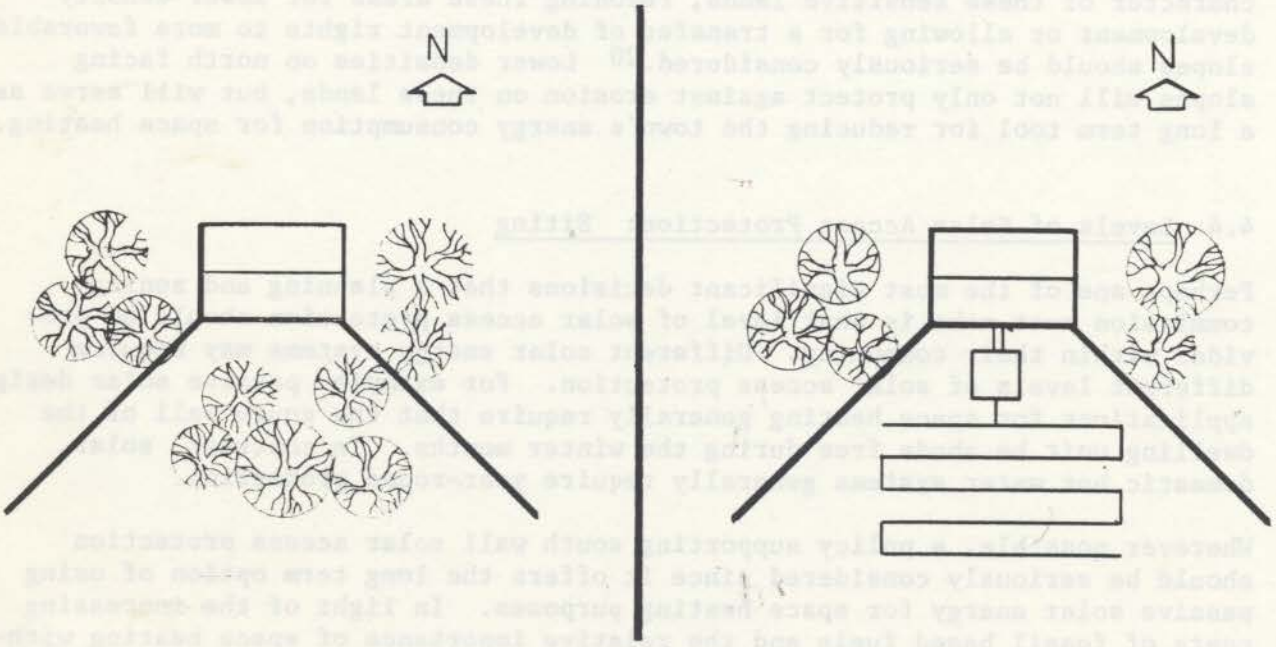


4.2 Septic System Leaching Field Location

The location of a septic system leaching field in developments not served by public sewers can be a significant factor in protecting future access to sunlight. In heavily vegetated areas, septic system leaching fields require

the cutting of tree cover in order to dig the trenches for the leaching fields. The placement of the leaching fields on the south side of the house ensures that significant shadow casting vegetation is removed in the early stages of development. (See Figure 24) Of course, the south side of the house may not be the best location for the placement of the septic system leaching field. The slope of the land, soil conditions and the location of the water well can influence the proper placement of the septic system. However, whenever possible the septic system should be constructed on the south side as long as it does not force the developer to construct an engineered septic system to meet this requirement. The Town of Middlebury, Connecticut requires that two test pits be dug for a septic system leaching field, one of which must be on the south side of the proposed dwelling unit.

Figure 24



SOLAR ACCESS PRIOR TO INSTALLATION OF LEACHING FIELD

SOLAR ACCESS AFTER INSTALLATION OF LEACHING FIELD

4.3 Steep Slope Development

Steep south facing slopes can be an energy asset for those interested in promoting the use of solar energy. Steeper south facing slopes offer greater levels of solar radiation per square foot than flat land, valuable windbreaks to northerly winter winds and increased levels of solar access protection. The combination of these three factors clearly indicates that south facing slopes are the equivalent of energy resource zones that can be "mined" if proper environmental precautions are taken.

In contrast, steep north facing slopes have little value for those interested in developing solar homes or solar subdivisions. Because of the diminished level of solar radiation, solar access is much more difficult to protect on a north facing slope than on a south facing slope. At 41° 30' north latitude (see Table 2) a 50-foot tree on a north facing slope of 15% will cast a 425 foot north shadow projection when the sun is located at 45 degree azimuth off True South on December 21st. In contrast, the same tree on a south facing slope of 15% will only cast a 120 foot north shadow projection. From both a solar access and energy conservation standpoint, it would be wise to limit new development on north facing slopes which exceed a grade of 15% (see Figure 25).

In light of the limited energy value of north facing slopes and the fragile character of these sensitive lands, rezoning these areas for lower density development or allowing for a transfer of development rights to more favorable slopes should be seriously considered.[20] Lower densities on north facing slopes will not only protect against erosion on these lands, but will serve as a long term tool for reducing the town's energy consumption for space heating.

4.4 Levels of Solar Access Protection: Siting

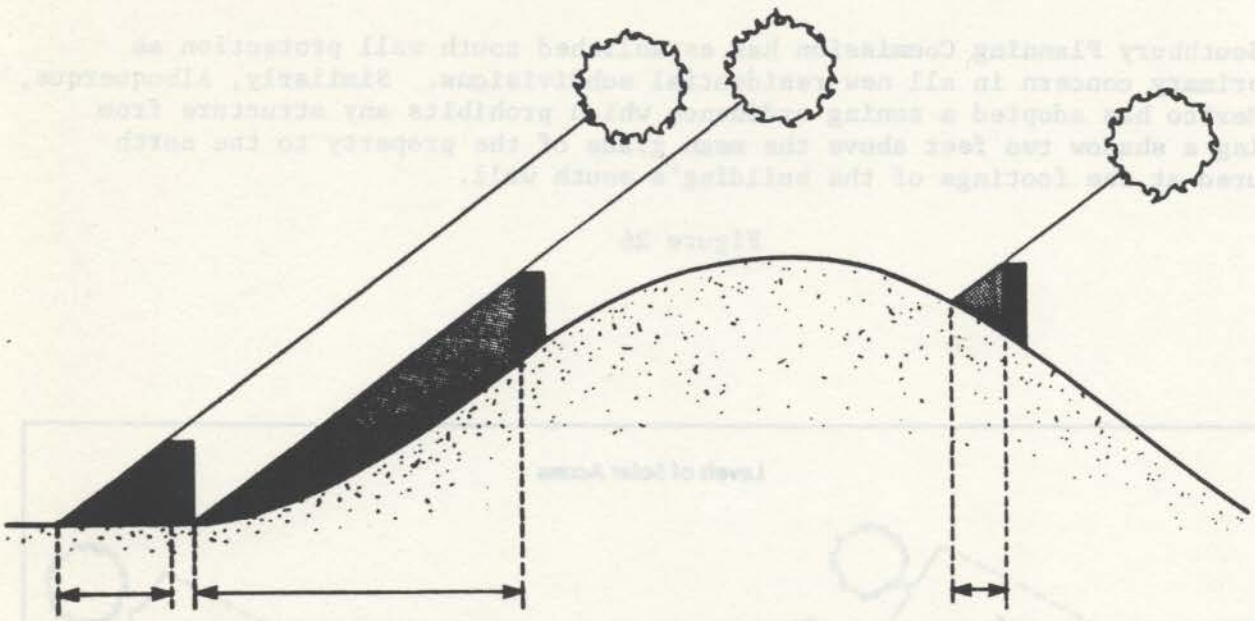
Perhaps one of the most significant decisions that a planning and zoning commission must make is what level of solar access protection should be provided within their community. Different solar energy systems may require different levels of solar access protection. For example, passive solar design applications for space heating generally require that the south wall of the dwelling unit be shade free during the winter months. In contrast, solar domestic hot water systems generally require year-round protection.

Wherever possible, a policy supporting south wall solar access protection should be seriously considered since it offers the long term option of using passive solar energy for space heating purposes. In light of the increasing costs of fossil based fuels and the relative importance of space heating within the consumer's energy budget, it is clear that protection of the south wall is a significant long term method of reducing energy costs for the homeowner and the community. Moreover, by protecting the south wall of a dwelling unit, a planning and zoning commission is automatically protecting rooftop solar access (see Figure 26).

Several municipalities in the United States have already established solar access standards including Southbury, Connecticut and Albuquerque, New Mexico.

Figure 25

Shadow Lengths Are Shorter and Higher Densities Easier on South Slopes



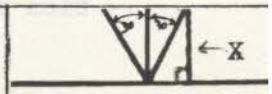
DISTANCE "X" ON A FLAT SLOPE IS LESS THAN DISTANCE "Y" ON A NORTH SLOPE, FOR IDENTICAL POLES. DISTANCE "Z" ON A SOUTH SLOPE IS THE LEAST.

Table 2: North Shadow Projection Table for 45° Azimuth Ratio of North Projection of Shadow Length to Height of Shadow Casting Object (assumes 45 degree azimuth for AM/PM shadow assessment)

Latitude	South Slope 25%	20%	15%	10%	5%	Flat	5%	10%	15%	20%	25%	North Slope
41°15'	1.92	2.11	2.37	2.68	3.10	3.66	4.49	5.78	8.15	13.74	43.87	
41°30'	1.93	2.14	2.40	2.72	3.15	3.74	4.60	5.97	8.51	14.82	57.23	
41°45'	1.95	2.16	2.43	2.76	3.20	3.81	4.71	6.16	8.90	16.04	80.88	
42°0'	1.97	5.36	2.45	2.80	3.25	3.89	4.82	6.36	9.33	17.47	137.74	

NOTE: The north shadow projection is the line designated by the letter X.

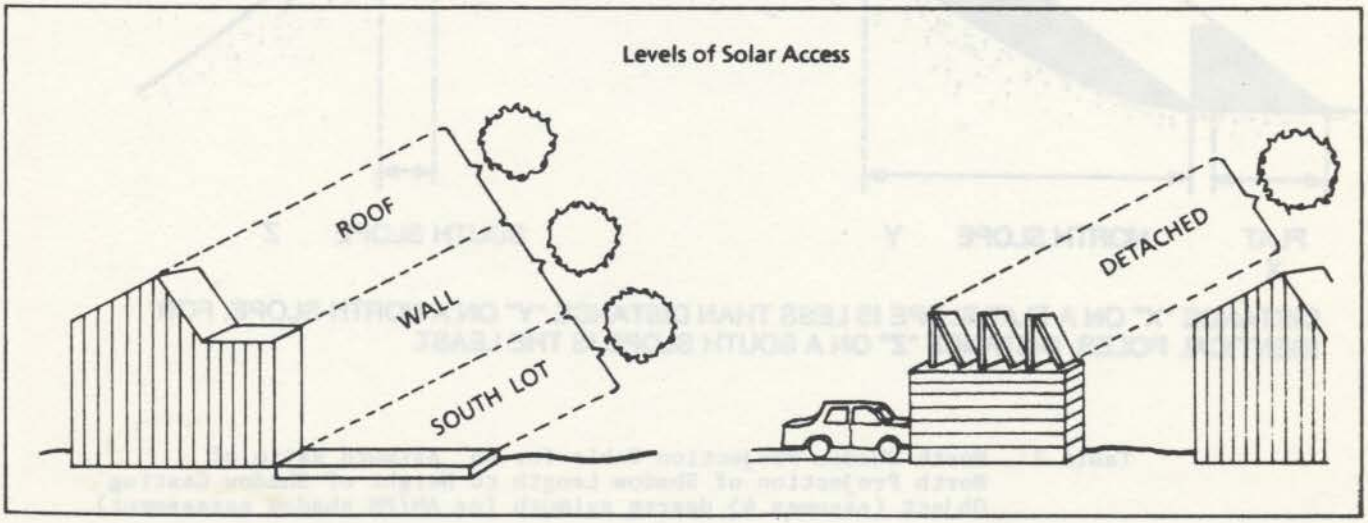
Table 3: North Shadow Projection Table for 30° Azimuth Ratio of North Projection of Shadow Length to Height of Shadow Casting Object (assumes 30 degree azimuth for AM/PM shadow assessment)

Latitude	South Slope 25%	20%	15%	10%	5%	Flat	5%	10%	15%	20%	25%	North Slope
41°15'	1.53	1.65	1.81	1.98	2.21	2.47	2.83	3.29	3.94	4.91	6.51	
41°30'	1.54	1.67	1.83	2.01	2.23	2.51	2.87	3.35	4.03	5.04	6.74	
41°45'	1.56	1.69	1.84	2.03	2.26	2.54	2.92	3.41	4.11	5.18	7.00	
42°0'	1.57	1.71	1.86	2.05	2.29	2.59	2.96	3.47	4.21	5.33	7.26	

NOTE: The north shadow projection is the line designated by the letter X.

The Southbury Planning Commission has established south wall protection as the primary concern in all new residential subdivisions. Similarly, Albuquerque, New Mexico has adopted a zoning ordinance which prohibits any structure from casting a shadow two feet above the mean grade of the property to the north measured at the footings of the building's south wall.

Figure 26



While there are limited examples of municipalities which have established solar access standards, the initial experience points to a strong concern for the long term protection of south wall solar access.

4.5 Levels of Solar Access Protection: Timing

Establishing a solar access policy not only requires a consideration of the amount of the lot and building that should receive sunlight, but the amount of time that the sun should be available. It is not necessary to have complete access to the sun. The important consideration is to have access to the sun during those critical hours of the day when the greatest level of solar radiation is available (see Table 4).

TABLE 4

RECOMMENDED SKYSPACE ANGLES FOR DECEMBER 21ST
A.M./P.M. POSITION*

LATITUDE	AZIMUTH	ALTUTUDE	NOON ALTITUDE	PERCENT RADIATION ON A SOUTH WALL**
41° 15'	45°	10.9°	25.3°	95%
41° 30'	45°	10.7°	25.1°	95%
41° 45'	45°	10.5°	24.9°	95%
42° 0'	45°	10.3°	24.6°	95%

* The A.M./P.M. angles presented in this chart are the same for both east of south and west of south. For example, if the skyspace azimuth is 45°, then the protected area goes from 45° east of south to 45° west of south.

** Radiation is based on the percentage of total available radiation falling on a surface perpendicular to the horizontal on December 21st. Example: If the skyspace between 45° east of south and 45° west of south is protected at 42° latitude, then 95% of the available radiation will strike a vertical south wall collector.

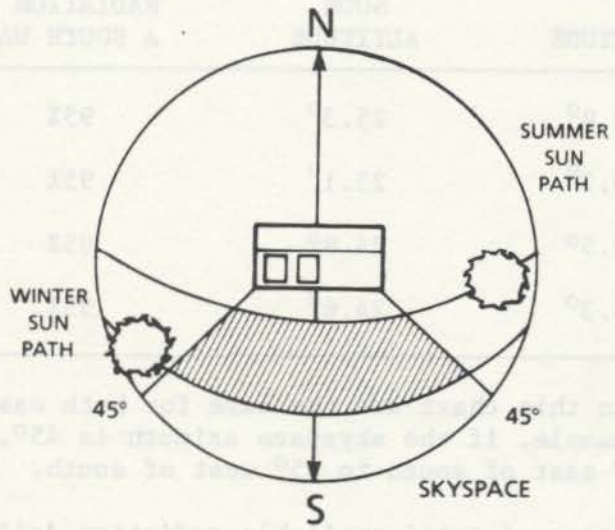
SOURCE: Prepared by the staff of the Central Naugatuck Valley Regional Planning Agency, August 1981 based on data in the 1978 Applications Handbook of the American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. p. 58.5.

It is generally not feasible or necessary to protect against shadows that are cast at sunrise or sunset. Distant topographic features and nearby trees can easily shade a solar collector or south wall of a house in the early morning and later evening hours when the sun is near the horizon. At these times the shadows cast on a collector may originate many hundreds of feet away on a neighbor's property. To control these shadows would generally lead to the confiscation of the development rights of neighboring property.

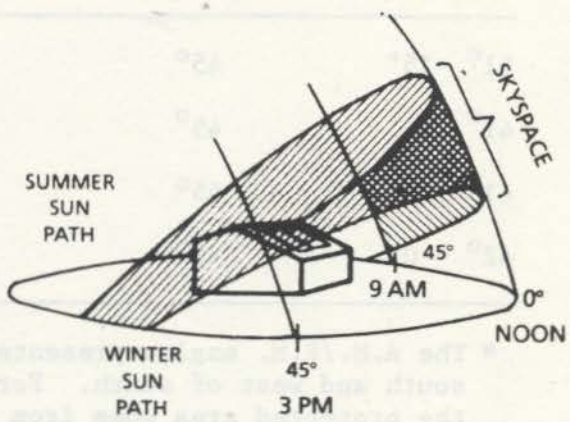
The most significant time of the year for evaluating solar access is on December 21st since this is the time when the sun's path through the sky is the lowest on the horizon (see Figure 27). Generally speaking, if solar access can be protected on December 21st, then it is likely to be available throughout the rest of the year. Most municipalities in the United States that have established solar access standards have chosen December 21st as the day for evaluating its availability.

Figure 27

Solar Skyspace (Plan View)



Solar Skyspace (Isometric View)



4.6 Levels of Solar Access Protection: Shading

It is not necessary to protect solar energy systems from every possible shadow that may fall upon a collector's surface. The key factor is to provide an adequate level of shade-free time for the solar energy system to function adequately. Shadows cast by bare branch deciduous trees, television antennas, flag poles, telephone poles, and other similar objects are the most obvious generators of shadows upon solar collectors. Fortunately, these structures generally do not create substantial shading problems.

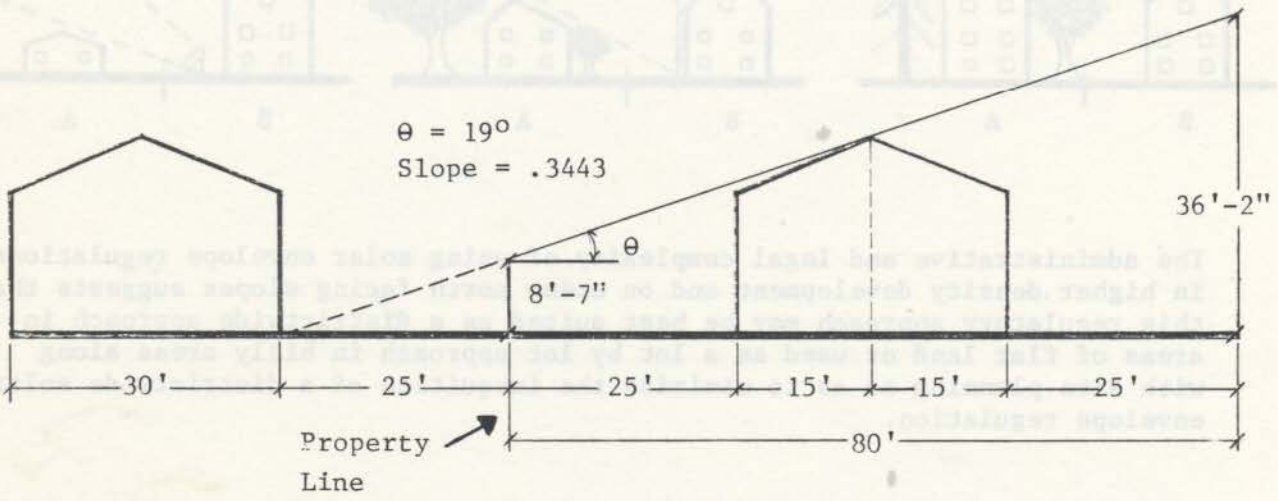
4.7 Solar Envelopes

Traditionally zoning has been used to control the maximum height and minimum setbacks of buildings and accessory structures on a lot. Conventional envelope zoning assumes that a structure may be built to the maximum allowable height anywhere within the prescribed setback limitations of the zone. This assumption may be consistent with the long term protection of solar access for adjoining lots when densities are relatively low. However, when minimum allowable lot sizes are 20,000 to 30,000 square feet, there may be some very real south wall solar access problems when a building to the south is built to the maximum allowable height and is set back the minimum distance from the property to the north.

In order to compensate for some of the solar access problems associated with conventional building envelopes, the Environmental Law Institute recommends

that solar envelope regulations be adopted. In its simplest form a solar envelope could be constructed as a property line based plane extending southwards and upwards at the altitude angle of the sun at 9:00 a.m. on December 21st. If this altitude angle should prove too restrictive for development to the south, the altitude angle of the sun at 10:00 a.m. on December 21st could be used instead. This method of protecting south wall solar access is graphically presented in Figure 28.

Figure 28

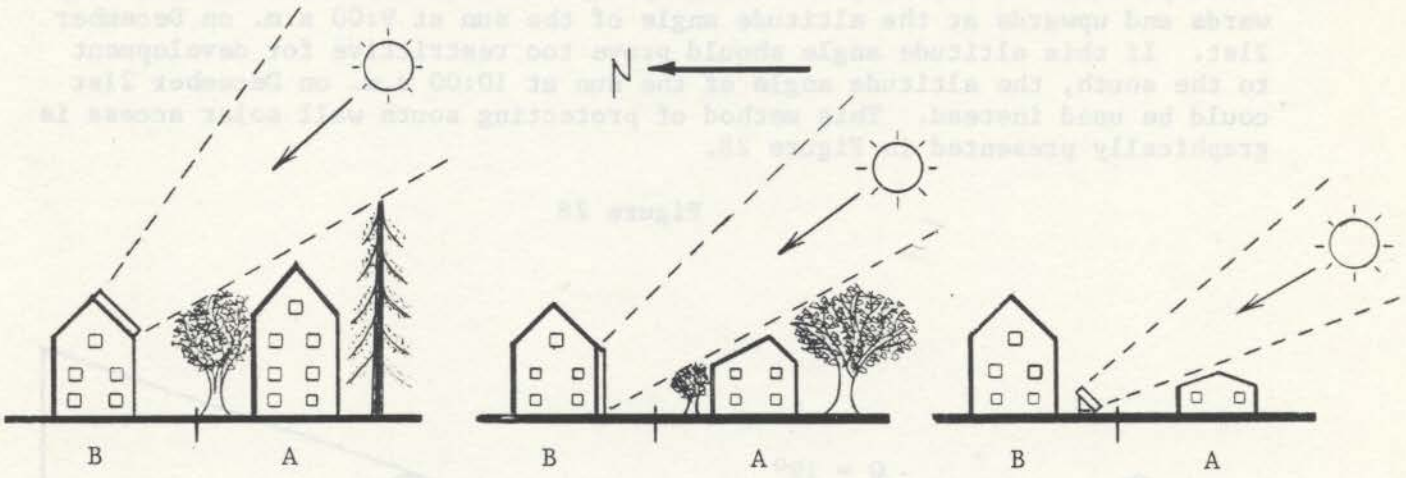


Property Line-Based Plane for Full South Wall Access in Waterbury, Connecticut - 41° 30' North Latitude

Solar envelope regulations offer a powerful tool for protecting solar access since they make it a matter of public policy that no solar energy system located on the south wall of a dwelling unit may be shaded by a building or object that protrudes through the adopted property line based plane.

The principal objection that has been raised against solar envelopes is that (1) they may constrain the development opportunities of land to the south, (2) they may be difficult to administer in regions with variable topography, and (3) they may be difficult to apply in high density urban areas. Figure 29 illustrates some of these issues. The extent of development allowed on Lot A depends upon the location of the collector on Lot B. Protecting access to sunlight for the south yard of Lot B may place too great a burden on the owner of Lot A whereas protecting access to sunlight for the rooftop of Lot B allows for a more dense pattern of development on Lot A.

Figure 29



The administrative and legal complexity of using solar envelope regulations in higher density development and on steep north facing slopes suggests that this regulatory approach may be best suited as a districtwide approach in areas of flat land or used as a lot by lot approach in hilly areas along with site planning so as to minimize the inequities of a districtwide solar envelope regulation.

4.8 Solar Easements

After all is said about the positive features of zoning as a vehicle for protecting solar access, a word of caution must be added. Zoning is subject to change. A zoning commission may decide to establish policies supportive of solar access but 10 years later decide that it is not a proper issue to be addressed by zoning. Or ten years from now the town may decide to disband zoning altogether thereby dissolving all of its policies for solar access protection. But perhaps more importantly, a zoning board of appeals may decide to vary the zoning regulations at the request of individual landowners. One can easily imagine a zoning variance being granted to build a house closer to the property line than allowed by zoning. Such a variance might also allow the neighbor to build a building that will cast a shadow over the solar energy system to the south.

There are two possible remedies to potential solar access problems created by variances granted by zoning board of appeals. In Connecticut, Public Act 77-509 allows a zoning commission to limit the extent to which the zoning board of appeals may vary the regulations. Very few municipalities have made use of the powers granted by this enabling legislation, probably because few understand its significance. The value of Public Act 77-509 is that it allows the zoning commission to protect the integrity of the town's zoning policies including any solar access protection policies it may adopt. A zoning commission may amend its regulations to stipulate that area regulations (i.e., height

limitations and setback requirements) may be varied by no more than 10% as long as the variance granted does not result in a shadow being cast upon an existing solar energy system. This approach maintains the integrity of the zoning regulation as long as zoning remains in force.

Should solar access protection under zoning fail, a homeowner or developer may wish to consider the use of a solar easement as backup protection. Solar easements can guarantee solar access to a solar energy system in a number of ways that a zoning regulation may not be able to do. For example, zoning regulations do not generally exercise any control over tree heights unless those trees are a public good (such as shade trees on the street) or a public liability (such as trees which may be interfering with overhead power lines or underground utilities). In contrast, a solar easement can establish the right to unobstructed sunlight over adjoining property which will require the adjoining landowner to prune or cut trees which protrude through the solar easement. A solar easement can also be used to limit future building development below the solar skyspace of the solar energy system, even if local zoning regulations allow for taller building heights. The purchase of a solar easement may be expensive or prohibitive in an existing development when an adjoining landowner has no interest in cooperating. For this reason, solar easements are most likely to be effective in new developments where a developer can include the solar easement as part of the deed to the property, thereby eliminating all transaction costs between neighbors. The solar easement would simply be a condition of sale of the lot or the house.

A planning commission can play an instrumental role in the use of solar easements by approving lots with inadequate solar access or all lots in the development only if a solar easement is provided. The subdivision map could indicate that a solar easement is one of the conditions for the approval of the lots. This approach is expressly supported by California's state enabling legislation, but such an approach could also be utilized by planning commissions in Connecticut without any new enabling legislation. The long-term value of this approach is that homeowners can install solar energy systems without any fear that their collector may be subject to future shadow problems.

5. Appropriate Nonregulatory Techniques for Protecting Access to Sunlight

A planning and zoning commission may be able to achieve many of its solar energy and solar access objectives without actually promulgating new regulations. It may be enough to simply convince local builders and developers that development of local renewable energy resources is an important public policy.

5.1 The "Solar Conscious" Review

As an example, a planning commission could promulgate administrative guidelines to their subdivision regulations which would provide commission members with insight into the means of protecting solar access. The commission could then have considerable influence upon the energy impact of a development application, even without solar regulations, simply by offering a "solar conscious" review of the preliminary subdivision application. Builders are all too aware that the success of their application sometimes rests heavily upon the informal policies of the commission, and so may be apt to include solar energy considerations in their proposal if they feel these considerations will help sell their package.

5.2 Solar Access Guidebooks

Some municipalities and counties in other parts of the United States have already published solar access guidebooks[21] as a means of educating local builders and developers who are not familiar with the basics of solar access and solar energy. This nonregulatory technique for promoting solar energy and protecting solar access can have a considerable impact upon local builders, developers and homeowners. A guidebook can be especially useful in protecting solar access for solar energy systems installed on existing dwelling units where neither a permit nor a review of the proposal would come before the planning and zoning commission. Many shading problems have emerged as a result of a lack of understanding of the principles of solar access as they apply to existing dwelling units. A solar access guidebook addressing the unique topographic conditions, solar access considerations and development limitations established by local zoning regulations could help to reduce uninformed decisions by homeowners concerning the location and orientation of solar collectors.

5.3 Model Solar Easements

A third nonregulatory technique which should be considered by planning and zoning commissions is the publication of model solar easements which could be made available to builders, developers and homeowners who propose any new developments or who plan to install some form of solar energy system in new residential developments. The preparation of a standard solar easement form for all new residential developments should help eliminate potential legal problems that may emerge if homeowners or builders attempt to draft their own solar easements.

5.4 Workshops

Finally, a planning and zoning commission may wish to make it a matter of policy to conduct periodic workshops for builders and developers to explain the importance of utilizing solar energy resources and protecting solar access. This approach is particularly valuable after a commission has adopted "solar conscious" zoning or subdivision regulations. Builders and developers may often resist or oppose solar energy or energy conservation ordinances if they perceive that the ordinance will increase the cost of housing or increase the paper work required for processing a zoning or subdivision application. These initial objections can often be overcome through workshops and seminars that educate builders and developers about the energy savings achieved by the new regulations. Once the regulations are properly understood and the benefits of the regulations are perceived, the local builders may ultimately become the strongest supporters of "solar conscious" regulations.

6. Policy Conflicts Created by the Protection of Solar Access

Despite federal and state laws supporting the development of "solar conscious" land use policies, solar energy policies may not be supported at the local level if conflicts exist with other established policies or concerns.

6.1 Increased Cost of Housing

One of the most significant issues that has been raised in municipalities that have already adopted solar access regulations is the impact of the regulation on the cost of housing. At several public hearings for solar access regulations held in Middlebury, Southbury and Cheshire, Connecticut, residents and engineers felt that the increased costs for meeting the mapping requirements for a solar subdivision might add several hundred dollars to the cost of the lot. This appears to be one of the most significant issues that a planning commission must face in developing a solar access amendment to its subdivision regulations. Increased mapping requirements must be kept to a minimum. When mapping requirements are added, they should be easily met and provide significant energy benefits to the future owner of the lot to justify the increased cost.

One way to avoid creating costly regulations is to evaluate the provisions of solar access regulations to determine their consistency with the "Least Cost Housing"[22] concept. Without an emphasis on a "least cost" approach to solar conscious land use regulations, the benefits of solar access and solar orientation policies may be inconsistent with the recent Connecticut legislation on solar subdivision design. The Act Concerning Passive Solar Design for Subdivisions specifically stipulates that the developer must "demonstrate to the commission that he has considered, in developing the plan, using passive solar energy techniques which would not significantly increase the cost of the housing to the buyer, after tax credits, subsidies and exemptions."

Perhaps one of the easiest means of ensuring that passive solar design techniques remain consistent with the provision of least cost housing is by minimizing or foregoing any mapping requirements for solar access protection zones, shadow projections or solar skyspace zones for passive solar homes. It should not be necessary to stipulate any additional mapping requirements as long as the commission becomes familiar with the principles of solar access and develops a simple procedure for evaluating the solar access potential for each dwelling unit within the development. The CNVRPA has developed a solar access setback mylar overlay for subdivision maps which makes it a simple matter to determine the shadow projections on each lot within a subdivision. The device can be used by a planning commission to ensure that solar access has been protected on each lot thereby avoiding the need to burden developers with additional regulations or mapping requirements. Copies of the solar access setback mylar overlay tool are available from the Energy Division of the Connecticut Office of Policy and Management.

6.2 Conflict with Existing Regulations

While builder reaction has generally focused on the cost of solar access reg-

ulations, local planning and zoning commission members have noted possible conflicts between solar access policies and other adopted land use policies. In the Central Naugatuck Valley Region, solar access regulations have come into conflict with existing standards for: (1) steep slope development, (2) street tree types, locations and heights, (3) street pattern policies, (4) density of development policies, (5) building height limitations, and (6) aesthetic controls over the appearance of solar homes or solar collectors. Each planning commission will undoubtedly arrive at a different determination as to the optimum choice between solar access and these existing policies. However, it appears that certain trends are emerging from the experience in Connecticut and in some western states.

In most cases, municipalities in the Central Naugatuck Valley Region have substantially altered existing policies for street trees, street patterns, lot lines and septic system locations where it could be clearly shown that such modifications would enhance the possiblility for solar energy system development and the protection of solar access.

Solar access protection policies can also conflict with existing policies supporting the vertical development of high density urban areas. Several urban centers are considering limiting vertical development within specified areas of their community in order to protect solar access. So far, only Albuquerque, New Mexico has reduced maximum allowable building heights. Moreover, this reduction was confined to residential zones where the impact upon development was not expected to be great. In contrast, it appears that larger urban areas may be much slower to adopt such a policy because of its obvious conflict with the vertical development of their downtown or other high density zones. Several ways of reconciling these conflicting objectives have been suggested including establishing building height limitations (like Albuquerque, New Mexico has done) to ensure that most existing buildings have adequate rooftop solar access. Another method is by adopting an ordinance declaring that solar access is a public resource to be protected for any solar energy system that has received a permit from the local planning department.[23]

Finally, several municipalities in the United States (including Bayonne, New Jersey and Coral Gables, Florida) believe that the development of solar energy systems may be in conflict with the protection of community aesthetics. The principal concern is that solar energy systems might be installed in front yards where they would be visible to neighbors or in an awkward position on rooftops of houses that were not originally built with solar access objectives in mind. Banning solar energy systems in front yards may not be a serious threat to the long term development of community solar resources. It may even be important to discourage ground locations for solar energy systems in certain circumstances since these locations are the most likely to be susceptible to shadow problems from neighboring property.

7. Practical Local Experiences with the Development of Solar Access Regulations

A number of municipalities in Connecticut have adopted solar access regulations, and their experiences provide valuable guidelines to other planning and zoning commissions considering "solar conscious" amendments to their regulations. Appendices 1 and 2 identify most of the municipalities and counties that have already adopted solar conscious land use regulations. These municipalities often dealt with a variety of regulatory, nonregulatory and procedural issues that can shed light upon the most suitable path for a land use commission to take when developing their own regulations. The experience of these communities suggests that if a regulation is to be successful the following procedural and administrative issues should be addressed:

1. holding a solar access education program for the planning and zoning commission and staff.
2. analyzing legal barriers to solar access in local regulations,
3. presenting alternative regulatory techniques for the commission to consider,
4. establishing public support for the regulations from the builders, citizens and key local government officials, and
5. taking an incremental approach to the promotion of solar energy systems and the protection of solar access.

7.1 Solar Access Education Program

Do not expect members of the planning and zoning commission or even the planning staff to be familiar with the concepts of active and passive solar energy systems, solar access, solar envelopes, solar skyspace and other terms that have emerged with the advent of "solar conscious" land use regulations. One of the most important reasons for hoding a solar access education program for the planning and zoning commission is that often commission members are not aware of the importance of solar energy as a renewable energy resource or of the critical role that they can play in either expediting or impeding the future development of solar energy systems. An education program can be particularly successful if the program is geared to the specific solar access problems of the community. For example, the Southbury, Connecticut Planning Commission and its staff were hesitant to establish a public policy supporting solar access until the Planning Administrator reviewed the last eight subdivisions approved by the town and found that all but one could easily have been made into a solar subdivision with minor changes in lot lines, building orientations or the location of septic system leaching fields.

One common experience found in a number of communities in the Northeast has been a hesitation to adopt solar access regulations simply because such regulations have mostly been adopted in California, Colorado and New Mexico. Many commission members firmly believe that solar energy makes sense but only in areas like New Mexico or California where there is a lot of sunshine. Two

things that should be mentioned if these arguments are encountered are: (1) the greater importance of protecting solar access and promoting the use of solar energy systems in the northeast due to the high cost of fossil based fuels, our long cold winters and the significant contribution that solar energy can make to our space heating and domestic hot water needs, and (2) examples of similar communities within the state or the region which have already adopted "solar conscious" land use regulations.

7.2 Analyze Legal Barriers

Many planners and commission members may feel that local regulations do not hamper the use of solar energy for space heating or domestic hot water. A review of local zoning and subdivision regulations as well as other land use codes can be quite useful since it will identify specific requirements or standards which might prohibit or impede the use of solar energy systems and which might not have been identified in more general studies done at the state or national level. However, most commission members will not have the time to undertake such a review on their own. The planning staff for the municipality or the region should undertake this type of analysis as one of the first steps in the process of developing "solar conscious" regulations.

Despite the value of eliminating legal barriers to the use of solar energy systems, it appears that most Connecticut municipalities are hesitant to undertake a thorough revision of their regulations in order to promote solar energy systems. The primary reason for the hesitation is probably the fact that solar energy systems have created very few land use problems. Moreover, when problems emerge, they are most often dealt with through a variance to the regulations. Lacking any real world pressure for change, the commissions are content to believe that their zoning and subdivision regulations are not causing any problems. The second apparent reason why some Connecticut zoning commissions have hesitated to alter their regulations to promote solar energy systems is the perception that the elimination of legal barriers may also result in unaesthetic "retrofit" applications of solar collectors within their community.

7.3 Present Alternative Regulatory Techniques

There is no single best way to protect solar access or promote the use of solar energy systems. The most appropriate regulatory approach taken in one municipality may be entirely unsuitable for a neighboring municipality. It is important to offer alternative regulatory techniques for consideration since there are many new tools for implementing Connecticut's legislation concerning passive solar subdivision design. While alternative approaches should be explored, the CNVRPA found that it was often easiest to develop and adopt a "solar conscious" land use regulation when the commission was already considering making substantial changes to specific sections of their zoning or subdivision regulations. In these instances, it was simply a matter of adding an additional energy conservation, solar energy or solar access consideration to the proposed regulations.

To facilitate the process of adopting "solar conscious" zoning and subdivision regulations the appendix to this quidebook contains a variety of model regulations addressing passive solar subdivision design, the protection of solar access and the elimination of land use barriers. These regulations should not necessarily be adopted in their present form but they may be used to guide a commission in its own efforts of revising local zoning and subdivision regulations.

7.4 Public Support for Local Regulations

Public support for "solar conscious" land use regulations is critical to the success of any efforts to adopt regulations. Middlebury, Southbury and Naugatuck, Connecticut have quickly developed and adopted solar access regulations largely because a few members on the planning commission, planning staff or local builders strongly and persistently advocated the adoption of "solar conscious" land use regulations. State support for "solar conscious" land use regulations as evidenced by the passage of An Act Concerning Passive Solar Design for Subdivisions will probably accelerate the rate at which planning commissions adopt suitable regulations: After October 1, 1981 all subdivision regulations in Connecticut must contain provisions that require applicants to consider passive solar design issues.

7.5 Develop Regulations Incrementally

It is not necessary to address all solar access and passive solar design issues by the October 1, 1981 deadline. To be consistent with the intent of the recent legislation, a more measured approach can be taken. The primary considerations that should be addressed at the outset are the provision of standards for the orientation of the street, lot line and building and the protection of solar access. "Solar conscious" site planning requirements coupled with the protection of solar access will provide the two basic tools for promoting passive solar subdivision design. As planning commission members become more comfortable with the basics of solar access, many commissions may wish to provide requirements for solar easements and the control of vegetation. While Public Act 81-334 clearly indicates that planning commissions can control vegetation in order to create a passive solar subdivision, it may be some time before strong subdivision controls are placed upon vegetation. Clearly, this Act will not change local attitudes about the control of vegetation overnight; but it should make planning officials more aware of the importance of considering vegetation as a possible impediment or aid to the creation of passive solar subdivision designs. In the case of Southbury, Connecticut, the planning commission concluded that trees might not be serious threats to solar access as long as they are deciduous. At the same time, the commission recognizes that evergreen trees may pose serious problems for owners of solar energy systems especially if these trees are located to the south of the solar collector. More experience with the review of passive solar subdivisions will determine the extent to which greater controls over vegetation will be required in order to protect solar access in Southbury. As can be seen in Appendix 2 only four out of 20 municipalities in the United States with "solar conscious" subdivision regulations have supported the use of easements to guarantee solar access to

solar collectors. However, solar easements may be required or supported by more municipalities as solar access problems become more apparent to the public and to local planning commission members.

Summary

The time for protecting solar access and considering passive solar design of subdivisions is now upon us. Techniques for promoting the use of solar energy systems and protecting solar access may be developed through a variety of regulatory and nonregulatory techniques including the adoption of "solar conscious" subdivision amendments for street, lot and building orientations, the adoption of solar access standards for passive and active solar energy systems and the establishment of policies to guarantee a "solar conscious" review of subdivision applications. Whatever approach is adopted, the important point to keep in mind is that the planning commission must be sure the developer has considered the application of the five passive solar design techniques set forth in Public Act 81-334 within all subdivisions submitted after October 1, 1981.

This can best be accomplished by adopting the five passive solar design techniques as subdivision policies or standards so as to assure consistency with Public Act 81-334 and to guarantee that all developers consider passive solar design techniques wherever they are feasible. Since there are very few instances where passive solar design techniques can not be applied to one degree or another, it should be the exception rather than the rule to waive the requirements for passive solar subdivision design. The overall objective of Public Act 81-334 is to increase our utilization of renewable energy resources. Consequently, the burden of proof for not incorporating passive solar design techniques into a proposed subdivision must rest with the developer.

FOOTNOTES

1. See Gail Boyer Hayes, Solar Access Law: Protecting Access to Sunlight for Solar Energy Systems, Environmental Law Institute, Washington, DC, 1979; Martin Jaffe, Protecting Solar Access for Residential Development: A Guidebook for Planning Officials, American Planning Association, Washington, DC, 1979; and Charles Vidich, Overcoming Land Use Barriers to Solar Access: Solar Planning Recommendations for Local Communities, Central Naugatuck Valley Regional Planning Agency, Waterbury, CT, 1980.

2. Prior to the adoption of Public Act 81-334 Connecticut planning commissions were encouraged to address energy conservation, energy efficient patterns of development and the use of solar and other renewable energy resources by enabling legislation created under Public Act 78-314. However, this enabling legislation did not result in any major revisions of zoning or subdivision regulations in the State.

3. A 1980 Gallup Poll pilot interview series concerning homeowners reaction to solar energy revealed that the right to light was never even raised as a possible barrier to the use of solar energy systems.

4. See Overcoming Land Use Barriers to Solar Access: Solar Planning Recommendations for Local Communities, p. 13.

5. See Solar Age, May 1981, "A National Study of the Residential Solar Consumer", p. 25.

6. Connecticut Energy Division, Office of Policy and Management, Report on Solar Domestic Hot Water System Inspections, 1978-1979, p. 2.

7. Franklin Research Center, First Passive Solar Home Awards, U.S. Department of Housing and Urban Development, Washington, DC, January 1979, pp. 4-5.

8. See Solar Age, May 1981, "A National Survey of the Residential Solar Consumer", p. 25

9. The Domestic Policy Review of Solar Energy, Washington, DC, U.S. Department of Energy, Washington, DC, February 1979. This report contains a detailed discussion of the feasibility of achieving the President's goal of 20% by the year 2000.

10. See Board of Supervisors, San Diego County, An Ordinance Relating to Plumbing to Require the Use of Solar Water Heating Systems in New Residential Construction, December 1978.

11. See Michael Shapiro, Boston Solar Retrofits: Studies of Solar Access and

Economics, John F. Kennedy School of Government, Harvard University, Cambridge, MA, December 1980, pp. 24-26. An estimated one-third of all of Boston's two and three story dwelling units have good south wall solar access.

12. Allan Miller, Overcoming Legal Uncertainties About the Use of Solar Energy Systems, Chicago, IL, American Bar Foundation, 1979, pp.48-51.

13. See Charles Vidich, Meeting the Energy Crisis: New Considerations for Planning and Zoning in the 80's, Waterbury, CT, Central Naugatuck Valley Regional Planning Agency, October 1979.

14. See Charles Vidich, Overcoming Land Use Barriers to Solar Access: Solar Planning Recommendations for Local Communities, p. 34, February 1980.

15. See Overcoming Land Use Barriers to Solar Access: Solar Planning Recommendations for Local Communities, pp. 75-79. This study contains a detailed analysis of the potential solar access problems that could emerge under the worst case conditions of local zoning for various street patterns on flatland, south slopes and north slopes in Connecticut.

16. There is no requirement that active solar collectors be oriented within 20 degrees of true south. However, the Connecticut Building Code encourages the use of this orientation standard.

17. See Duncan Erley, Site Planning for Solar Access, Washington DC ,American Planning Association, 1979, p. 55 and U.S. Department of Housing and Urban Development, Intermediate Minimum Property Standards Supplement: Solar Heating and Domestic Hot Water Systems, Washington, DC, 1977 Edition, An Illustrated Solar Appendix, p. C11.

18. See Solar Age, December 1980, "Collector Location: No Taboos on East or West," p. 26.

19. One particularly effective and inexpensive means of evaluating potential solar access problems within a subdivision is through the use of the solar access setback mylar overlay. This tool can be used by a planning commission or a builder to make a quick evaluation of potential solar access problems that may be created by lot size, lot orientation, house location or house orientation. Copies of the Solar Access Setback Mylar Overlay and an explanation of how to use this simple tool are available from the Energy Division of the Connecticut Office of Policy and Management.

20. Any Municipality that intends to revaluate residential densities in light of solar access considerations should base their decisions in part upon the data provided in Table 2. The North shadow projection data for Connecticut latitudes can be used to establish minimum lot requirements consistent with the protection of solar access. For a more detailed treatment

of this subject see Protecting Solar Access for Residential Development: A Guidebook for Planning Officials.

21. See Building Inspection Department, Santa Clara County, Guidelines for Solar Exemptions, Santa Clara, CA, 1980; Department of Planning and Land Use County of San Diego, Solar Water Heating Systems Informational Guidelines, San Diego, CA, 1979; Southbury Planning Commission, Administrative Policy #6: Energy Conservation in Subdivisions, Southbury, Connecticut, 1981; Multnomah County Residential Energy Conservation Handbook, Portland, Oregon, November 1979; Addison County Regional Planning and Development Commission, Solar Commercialization in Addison County, Vermont, Middlebury, VT, 1980; and Central Naugatuck Valley Regional Planning Agency, Meeting the Energy Crisis: New Considerations for Planning and Zoning in the 80's, Waterbury, CT, October 1979.

22. See Charles Vidich, Least Cost Housing: Minimizing the Fiscal Impact of Zoning and Subdivision Regulations, Waterbury, CT, CNVRPA, November 1978.

23. The solar recordation approach as it is called is in use in Woodburn, Oregon and offers a case by case procedure for resolving the conflicting objectives of solar access protection and vertical development.

An Introduction to the Resources Section: Solar Energy Ordinances

There are a variety of solar regulations which are emerging to address the multifaceted problems created by the development of solar energy systems and the protection of solar access. As of June 1981 there were as many as 40 different adopted solar regulations throughout the United States. Most of the adopted regulations address a variety of issues. However, for the sake of clarity, it is helpful to isolate the distinct regulatory approaches which are emerging. Solar regulations can be classified into six distinct types:

1. Regulations removing existing barriers:

   Typical regulations that have addressed the removal of legal barriers to the use of solar energy systems have focused on the relaxation of setbacks requirements and providing building height exemptions for solar energy systems. The Governments of Del Mar, California, The County of San Diego, California, Madison, Connecticut and Ferrisburgh, Vermont have all attempted to remove legal barriers from their zoning ordinances. The adopted regulations for Del Mar, California are perhaps the best example of this regulatory approach and are included in the resource section.

2. Regulations requiring solar conscious subdivision design

   One of the most significant areas of regulatory reform involves the adoption of subdivision amendments which encourage proper orientation of houses, lots and streets. This regulatory approach is one of the most popular approaches since it ensures that all future development is properly oriented to maximize the use of solar energy for space heating or domestic hot water. The Governments of Middlebury, Connecticut, Southbury, Connecticut, Madison, Wisconsin, Sacramento, California, Denver, Colorado, Santa Clara County, California, Port Arthur, Texas, Aspen, Colorado, Lincoln, Nebraska, Los Alamos, New Mexico, Ferrisburgh, Vermont, Naugatuck, Connecticut and Albuquerque, New Mexico have included regulations containing policies on solar conscious street, lot or building orientations. The adopted regulations for Southbury, Connecticut are perhaps one of the best examples of this approach since their regulations have addressed solar conscious street, lot and building orientations. A copy of Southbury's regulations are included in the resource section.

3. Regulations providing incentives for the utilization of solar energy systems

   Several municipalities in the United States now offer density bonuses or reduced development costs to builders and developers who include solar energy and energy conservation considerations into new developments. The most significant incentive regulations for solar energy systems are those adopted by Lincoln, Nebraska and Ashland, Oregon. Both of these local governments offer density bonuses in exchange for the mandatory installation of solar energy systems, and the proper orientation of street and lots.

4. Regulations utilizing solar energy considerations as a factor in selecting new growth

Growth Management regulations and Planned Development regulations have utilized solar energy considerations as a factor in evaluating the overall suitability of certain types of new development proposals in certain areas of the United States. For example, Boulder, Colorado controls the amount of new multi family housing through a Residential Allocation System which evaluates the merits of new development proposals based on a variety of factors including its energy efficiency and its use of solar conscious siting and building practices.

5. Regulations mandating the installation of solar energy systems in new development

A growing number of California counties and cities have adopted local ordinances requiring the installation of solar energy systems in all new residential developments. Counties and municipalities which have required the installation of solar energy systems have generally limited the requirement to domestic hot water heating or swimming pool heating involving new construction. However, at least one municipality requires the retrofit installation of solar domestic hot water systems on all residential units sold after 1982. Perhaps the best examples of this mandatory approach are in southern California. They include, San Diego County, California, Santa Clara County, California, Santa Barbara County, and Davis, California.

6. Regulations protecting solar access

Solar access protection has become a dominant consideration in many local regulatory approaches. The method of protecting solar access varies dramatically amongst these local governments which have adopted standards for solar access protection.

Two basic regulatory approaches have emerged: (1) lot by lot solar access protection accomplished through a solar access recordation permit, and (2) area wide solar access protection accomplished through uniform standards for the siting of solar energy systems and the level of solar radiation to be provided to solar energy systems within each zoning district of the municipality. The Solar Access Recordation Permit approach is being used in Woodburn, Oregon and requires a case by case analysis of the solar access available to each solar energy system prior to the issuance of a permit guarranteeing total protection from shadows cast by new buildings or structures and new vegetation to the south of the solar energy system. The area wide protection approach has been accomplished in a variety of ways including the use of solar bulk planes (Albuquerque, New Mexico), Solar setback provisions (Ashland, Oregon), protecting solar access by the use of a hypothetical south wall on the lot line (Los Alamos, New Mexico), reduced building height standards within specific zoning districts to protect solar access (Albuquerque, New Mexico), limiting variances to building heights or controlling building height exemptions to protect solar access (Wolcott, Connecticut) and establishing public control over vegetation to control one of the most significant threats to solar access (Woodburn, Oregon). A copy of the Albuquerque, New Mexico ordinance is included in the Resource Section.

Appendix 1: Zoning Standards, Policies and Regulations Used by Municipalities with Adopted Solar Access or Solar Energy Amendments: 1981

Jurisdiction	Inclusion of Definitions for Solar Access and Solar Energy Equipment	Inclusion of Solar Access Policies and Guidelines	Provision of Height Exemption for Solar Collectors	Provision of Setback Exemptions for Solar Collectors or Other Apparatus	Provision of Building Envelope or Bulk Plane Standards	Exemption of Solar Collectors from the Determination of Maximum Lot Coverage	Amendments Permitting Solar Energy Systems in Residential Zones	Inclusion of Planned Unit Development Regulations Offering Increased Density for Solar Developments	Increased Building Setbacks to Protect Solar Access to Northern Property	Provision of Building Height Limitations to Protect Solar Access	Exemption of Solar Collectors from the Standards for Glare & Reflection	Required Screening of Solar Collectors to Meet Aesthetic Standards
DelMar CA	X	X	X	X		X						
San Diego CA			X									
Madison CT			X									
Somers CT	X											
Wolcott CT		X										
Aspen CO	X					X						
Coral Gables FL												
Los Alamos NM	X	X										X
Albuquerque NM		X	X		X				X	X		
Moorhead MN	X			X		X	X	X				
Northfield MN		X	X	X	X	X	X					
Lincoln NB				X				X				
Ashland OR	X	X							X			
Woodburn OR	X	X			X							
Ferrisburgh VT	X										X	
King County WA				X	X							
Kirkland WA					X							
Total	8	7	5	5	5	4	2	2	2	1	1	1
PERCENT OF COMMUNITIES ADOPTING EACH MEASURE	47	41	29	29	29	24	12	12	12	6	6	6

Source: CNVRPA staff work based on data collected from the Planning & Zoning Commissions, Planning Department or City Clerks in each jurisdiction, April 1981

Appendix 2: Subdivision Standards, Policies and Guidelines Used by Municipalities with Adopted Solar Access Amendments: 1981

Jurisdiction	Regulations Containing Policies on Proper Solar Orientation			Inclusion of Solar Access Policies and Guidelines	Support for Energy Efficient Landscaping and Wind Barriers	Required Review of Solar Access Impact of Street Trees	Required Mapping of Shadow Projections or solar Access Zones	Support or Consideration for Solar Easements	Support for the Use of Open Space for Community Solar Energy Systems or Solar Access Buffers	Required Minimum Number of Solar Lots within Subdivision
	Street	Lot	Building							
Sacramento CA	X	X	X							
San Diego County CA				X						
Santa Clara County CA	X	X	X	X	X		X	X		
Aspen CO	X		X	X	X			X	X	
Denver CO	X	X	X	X	X	X				
Middlebury CT	X	X	X	X	X	X	X			
Naugatuck CT	X	X	X	X	X	X	X			
Southbury CT	X	X	X	X	X	X	X	X	X	
Millbury MA	X									
Lincoln NB		X	X	X		X				
Albuquerque NM	X									
Los Alamos NM	X	X		X						
Moorhead MN	X									
Northfield MN	X	X	X	X				X	X	X
Eugene OR				X			X			
Forest Grove OR		X	X	X						
Port Arthur TX	X	X	X	X						
Addison VT			X		X					
Ferrisburgh VT	X		X	X	X	X				
Madison WI	X	X	X							
TOTAL	15	12	14	14	8	6	5	4	3	1
Percent of Communities adopting each measure	75	60	70	70	40	30	25	20	15	5

Source: CNVRPA staff work based on data collected from the Planning and Zoning Commissions or Planning Departments in each jurisdiction, April 1981.

Proposed Amendments to the Subdivision Regulations of the

Town of Oxford, Connecticut

Add two new sections to Chapter 11 Definitions to define passive solar energy techniques and solar access as follows:

Section 2.3.7 Passive Solar Energy Techniques: Passive Solar Energy Techniques shall mean the utilization of (1) house orientation, (2) street and lot layout, (3) vegetation, (4) natural and man-made topographical features and (5) the protection of solar access within the subdivision as tools for maximizing solar heat gain, minimizing heat loss and providing thermal storage within a building during the heating season and for minimizing heat gain and providing for natural ventilation during the cooling season.

Section 2.3.8 Solar Access: The term "solar access" means the access to unobstructed direct sunlight required by a solar collector for its efficient operation. Solar access will be considered adequately available if the south wall of a proposed building has unobstructed access to sunlight for 75 percent of the time between 8:34 A.M. and 3:08 P.M. local time on December 21st.

Amend Section 6.2.2 Required Information-Plan under Chapter VI Maps and Plans to require location and orientation of proposed buildings and the square on the lot as follows:

(g) The locations and orientations of proposed buildings and structures indicating the availability of south wall solar access to all proposed principal buildings. Where solar access is not available to the proposed building site, the applicant or surveyor shall note "full south wall solar access not available."

(h) The location of the square on the lot.

Amend Section 6.3.2 Required Information-Overall View to require the location of proposed buildings as follows:

(b) Location, nature and extent of all other proposed construction including those structures which shall be the principal uses or accessory thereto and including, but not limited to public water, storm water and sanitary sewer facilities.

Amend Section 9.6.7 Lot Lines to Chapter IX Subdivision Design Standards and Requirements to provide for control of lot line orientation as follows:

All lot lines shall be 90 degrees or radial to the street line as close as possible. More flexibile lot line orientations shall be considered whenever such flexibility increases the solar access protection available to building lots within the development.

Amend Section 9.16.2 Percolation Tests to Chapter IX Subdivision Design Standards and Requirements to provide control over the location of the percolation tests as a tool to increase solar access as follows:

One percolation test, taken in accordance with the Oxford Sewage Disposal Ordinance shall be taken on each lot by the Sanitation Inspector of the Town of Oxford as indicated on the application. Primary and reserve leaching fields shall be planned and located to the south of the proposed building location whenever such location is feasible based on soil and topographic conditions.

Add Section 9.27 Building Orientation Standards to Control the Orientation of Proposed Buildings as follows:

The subdivision map shall identify on each parcel the ideal site and orientation for proposed buildings so that maximum application can be made of passive solar energy for space heating and cooling. All proposed buildings shall be located within the square on the lot and shall be oriented so that the longest sides of the building faces within 30 degrees of true south. No principal building shall be constructed outside of the square on the lot.

Add Section 9.28 Solar Access Standards to assure a basic level of south wall solar access protection to all proposed buildings as follows:

In considering the suitability of land for development, the Commission will also take into consideration the extent to which passive solar energy techniques including but not limited to topography, buildings and vegetation affect the level of solar access available to each building lot. Solar access will be evaluated based on the shadow projections that could be cast if a building to the south is built to the maximum height limitations allowed by the zoning ordinance and is located anywhere within the buildable area of the square on the lot. Solar access evaluation will be based on the Guidelines contained in the Memorandum titled "Procedure for Evaluating Solar Access as required by the Subdivision Regulations" available at the Town Planner's Office. Where solar access is not available anywhere within the square on the lot the applicant or surveyor shall note "Full south wall solar access not available."

Add Section 9.27.1 Solar Easements to provide the Commission the option of full south wall solar access as follows:

Solar Easements: At the discretion of the Commission, taking into consideration the need for permanent south wall solar access protection, the applicant may be required to include solar easements or restrictive covenants with the deed of each lot to guarantee the continuous usability of the passive solar energy systems incorporated into the design of the proposed buildings. Such solar easements or restrictive covenants, if required, must provide for unobstructed solar access between the hours of 8:34 A.M. local time and 3:07 P.M. local time on December 21st of any year.

Add Section 9.28 Relation to Adjoining Street System to add the following paragraph to require that streets be oriented in an east-west or north-south direction whenever possible to aid in the application of passive solar energy techniques for space heating and cooling as follows:

The orientation of the proposed street system shall provide for east-west or north-south street systems wherever topographic conditions permit, whenever such orientations would not be inconsistent with continuation of principal existing and proposed streets and whenever such orientations would not conflict with the requirements of Section 9.10 Street Intersections and Curves. For the purposes of this regulation east-west and north-south streets refer to any street that has an orientation within 30 degrees of true east or true north respectively.

Procedure for Evaluating Solar Access as Required
by the Subdivision Regulations of the Town of Oxford

Section 1. Data Requirements for Solar Access Evaluation. The availability of south wall solar access protection shall be evaluated for all proposed building locations using the solar access setback overlay. In order to use the solar access setback overlay it is necessary to first determine the following:

1. The orientation and slope of the land to the south side of the proposed building site.
2. The direction of true north on the map.
3. The scale of the map.

Based on these factors the applicant shall evaluate solar access assuming the following heights for buildings, and trees located within lines drawn at a 45 degree azimuth of true south from the southerly corners of the south wall of the building:

Shadow Casting Objects	Assumed Height for Purposes of Evaluating Solar Access
1. Buildings	35 feet
2. Evergreen Trees	50 feet

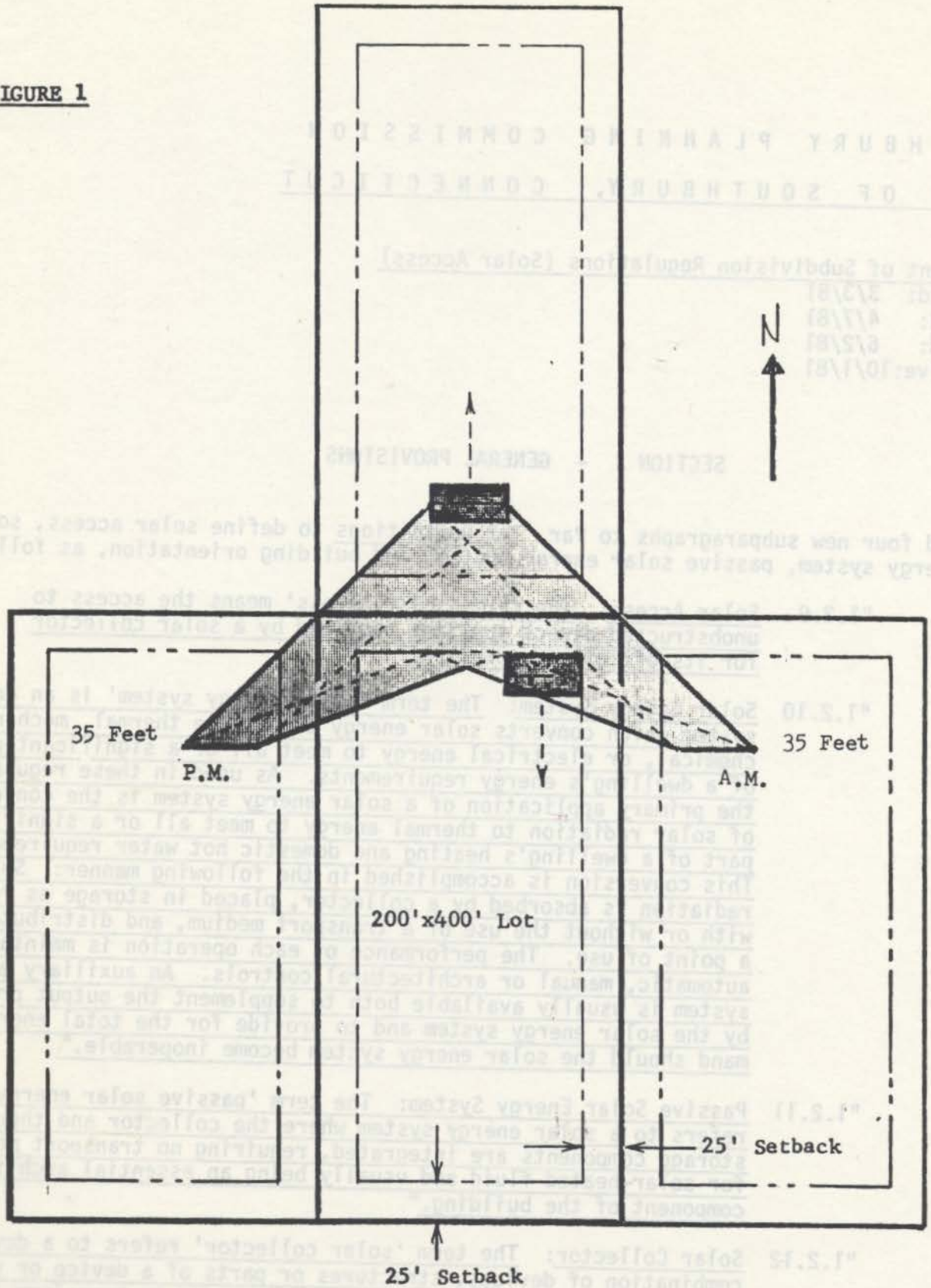
The solar access setback overlays have been developed for application on subdivision maps that have a scale of one inch equals 100 feet and one inch equals 40 feet. If other mapping scales are used for the subdivision map, the applicant must develop his/her own solar access setback overlays using the shadow projection data contained in Table 1.

Section 2: Procedure for Evaluating Solar Access. The applicant shall select the appropriate solar access setback overlay by determining the slope and orientation of land to the south of the proposed building. A total of 30 different overlays are available for the eight points of the compass and for five different slope conditions. Select the overlay which comes nearest to the exact orientation and slope of the land. Place the overlay on the subdivision map so that the south arrow on the overlay points in the opposite direction from the true north arrow on the map. Then line up the grid line at the apex of the solar access setback overlay so that it touches the corner of the south wall of the proposed building for which solar access is being evaluated. Next, move the solar access setback overlay to the opposite corner of the south wall. If any building falls within the 35 foot solar access setback line using this procedure the applicant must reconsider the location of one or both proposed buildings to provide unobstructed solar access to the south wall of the proposed building for which solar access is being evaluated. (See Figure 1.)

After evaluating the possible shadows cast by buildings the applicant shall evaluate the shadows that could be cast by evergreen trees. Use the 50 foot zone on the solar access setback overlay to determine the minimum setback for evergreen trees. No evergreen tree shall be allowed in the zone delineated by the 50 foot line on the solar access setback overlay unless the applicant has included solar easements or restrictive covenants with the deeds of each lot to guarantee each lot owner control over solar access to the south wall of the proposed building between the hours of 8:34 A.M. local time and 3:08 P.M. local time.

Section 3: Review and Variance by Planning and Zoning Commission. The Planning and Zoning Commission will review the proposed building locations to ensure that solar access is available for 75 percent of the time between 8:34 A.M. and 3:08 P.M. local time on December 21st. Where this minimum level of solar access protection is not available, after due consideration has been given to locating the proposed building in the most favorable area on the lot for protecting solar access, then the Commission may waive the solar access requirements of the subdivision regulations. All lots that do not meet the solar access requirements of the regulations shall be listed on the subdivision map with the notation "Full south wall solar access not available on lots ....."

FIGURE 1



Scale: 1" = 100'

Site Specific Evaluation of Solar Access on Flat Land

SOUTHBURY PLANNING COMMISSION

TOWN OF SOUTHBURY, CONNECTICUT

Amendment of Subdivision Regulations (Solar Access)
Proposed: 3/3/81
Revised: 4/7/81
Adopted: 6/2/81
Effective: 10/1/81

SECTION I - GENERAL PROVISIONS

A. Add four new subparagraphs to Par. 1.2 Definitions to define solar access, solar energy system, passive solar energy system, and building orientation, as follows:

"1.2.9 Solar Access: The term 'solar access' means the access to unobstructed direct sunlight required by a solar collector for its efficient operation."

"1.2.10 Solar Energy System: The term 'solar energy system' is an energy system which converts solar energy to useable thermal, mechanical, chemical, or electrical energy to meet all or a significant part of a dwelling's energy requirements. As used in these regulations, the primary application of a solar energy system is the conversion of solar radiation to thermal energy to meet all or a significant part of a dwelling's heating and domestic hot water requirements. This conversion is accomplished in the following manner: Solar radiation is absorbed by a collector, placed in storage as required, with or without the use of a transport medium, and distributed to a point of use. The performance of each operation is maintained by automatic, manual or architectural controls. An auxiliary energy system is usually available both to supplement the output provided by the solar energy system and to provide for the total energy demand should the solar energy system become inoperable."

"1.2.11 Passive Solar Energy System: The term 'passive solar energy system' refers to a solar energy system where the collector and thermal storage components are integrated, requiring no transport medium for solar-heated fluid and usually being an essential architectural component of the building."

"1.2.12 Solar Collector: The term 'solar collector' refers to a devise or combination of devices, structures or parts of a device or structure that require access to sunlight in order to transform direct solar energy into thermal, mechanical, chemical, or electrical energy that will contribute significantly to a structure's energy supply."

"1.2.13 Building Orientation: The term "building orientation" refers to the relationship of a building's longest axis to the true south compass point. Optimal building orientation for detached housing usually occurs when the building's longest axis is east to west (90° from true south) with acceptable variations of 10° to the northwest and 25° to the southwest."

SECTION 2 - APPLICATION REQUIREMENTS AND PROCEDURE

B. Add a new subparagraph to subparagraph 2.3.4 Additional Evidence of Par. 2.3 Additional Requirements to enable the Planning Commission to ask for additional information to establish that solar energy requirements have been taken into account in the planning and design of the subdivision by adding a new subparagraph 2.3.4g as follows:

"2.3.4g that provision has been made in the planning and design of the subdivision to enable the use of solar energy systems to the maximum extent possible."

SECTION 3 - STANDARDS FOR MAPS AND PLANS

C. Amend subparagraph 3.2.3 of Par. 3.2 Site Development Plan to require that the Site Development Plan show both the true and magnetic north points as follows:

"3.2.3 date, including revision dates and a brief description of all revisions; scale; true and magnetic north points; Town; and State."

D. Add a new subparagraph 3.2.19 of Par. 3.2 Site Development Plan to require the Site Development Plan to show areas of tree removal necessary to achieve good solar access as follows:

"3.2.19 the limits of any areas of tree removal necessary to provide effective use of a passive solar energy system, based on an assumed mature tree height of fifty feet."

E. Amend subparagraph 3.3.3 of Par. 3.3 Record Subdivision Map to require that the Record Subdivision Map show both the true and magnetic north points as follows:

"3.3.3 date, including revision dates and a brief description of all revisions; scale; true and magnetic north points; Town; and State."

SECTION 4 - DESIGN AND CONSTRUCTION STANDARDS

F. Amend subparagraph 4.8.1 of Par. 4.8 Natural Features to preserve the natural features of the tract by avoiding regrading which would decrease the amount of solar access of the tract as follows:

"4.8.1 by avoiding cuts or fills which result in potential soil erosion and excessive tree removal, which disturb water resources, or which would adversely affect the solar access of the tract;"

G. Amend subparagraph 4.8.4 of Par. 4.8 Natural Features to require that the planning and design of a subdivision take into account existing vegetation which serves energy conservation purposes as follows:

"4.8.4 by avoiding removal of large isolated trees and desirable woods and other vegetation, particularly those existing plant materials which serve as wind barriers and aid energy conservation."

H. Amend subparagraph 4.9.5 Lot Lines of Par. 4.9 Building Lots to permit lot lines to take into account orientation to the sun as follows:

"4.9.5 Lot Lines: Insofar as practicable, the side lot lines of all lots shall be at right angles or radial to the street on which the lot has frontage, unless the purpose of lot line orientation other than those mentioned is to secure greater solar access or protection or control thereof. It shall be within the discretion of the Commission to disapprove any lot crossed by a municipal boundary line, and, in the event of such disapproval, such boundary line shall be made to constitute one of the lot lines."

I. Amend subparagraph 4.10.2 On-Site under Par. 4.10 Sewer and Water to require leaching fields to be proposed in locations to aid solar energy by adding a new subparagraph 4.10.2c as follows and relettering the other subparagraphs accordingly:

"4.10.2c Provided soil and topographic conditions permit, primary and reserve leaching fields shall be planned and located to the south of a proposed house location whenever such location will aid the use of solar energy systems due to improved solar access caused by regrading and tree removal associated with the installation of the sewage disposal system."

J. Amend subparagraph 4.11.2b under subparagraph 4.11.2 Street Planning of Par. 4.11 Street Planning and Design to require that streets be oriented in an east-west direction whenever possible to aid the use of solar energy systems as follows:

"4.11.2b Streets should, in general, follow the contour of the land and should have a location and grade which accomplishes an attractive layout and development of the land, which preserves natural terrain, large isolated trees and desirable woods and other vegetation and which will enhance property values in the subdivision. When few natural constraints exist which limit street layout and location, such as, but not limited to, steep slopes and unsuitable soils, streets shall have an east-west orientation to the greatest extent possible with acceptable variations of 10° to the northwest and 25° to the southwest in order to provide for orientation of lots and buildings to the south, and thereby to encourage the use of solar energy systems."

K. Amend subparagraph 4.18.1 Character and Access under Par. 4.18 Open Spaces, Parks and Playgrounds to require that the location of proposed open spaces take into account the extent of solar access provided each proposed lot in the subdivision as follows:

"4.18.1 Character and Access: The land reserved shall be of such size, location, shape, topography and general character as to be useful to satisfy the needs determined by the Commission. Proper pedestrian and vehicular access shall be provided each such reservation. The location of such land shall take into account the solar access of the entire subdivision as deemed necessary by the Commission as follows:

a. If a substantial number of lots have adequate solar access as determined by the Planning Commission under subparagraph 4.24.1, land for open space reservation shall be located in such a manner as to avoid the creation of lots not capable of effectively using solar energy systems.

b. If the tract of land is such that a substantial number of lots cannot be provided with adequate solar access, land for open space reservation shall, whenever possible, be located on a portion of the tract which does have adequate solar access in order to provide for the present or future use of community solar energy systems."

L. Amend Par. 4.22 Street Trees to require that the location and species of street trees in subdivisions do not conflict with solar access objectives as follows:

"4.22 Street Trees: Where there are insufficient existing trees within the subdivision, the Commission may require the planting of street trees. In general, street trees shall be planted approximately fifty feet apart on both sides of any street and adjacent to the street right-of-way subject to variations in location made necessary by conditions such as driveways, street corners, sidewalks, topography and planting conditions. Street trees shall be located in such a manner as to avoid shading the most southerly side of proposed dwelling locations in order to facilitate the use of solar energy systems. Trees to be planted shall be at least 1-3/4 inch diameter breast high and shall have a minimum height of 10 feet. The species of trees shall be selected taking into account its compatability with solar access objectives and shall be subject to the approval of the Commission. Where the trees may interfere with utility poles and wires, the Commission may permit the location of required trees within the front ten feet of the proposed lots. Existing trees along the proposed street which conform to these requirements may be substituted for new trees at the discretion of the Commission."

M. Add a new Par. 4.24 Energy Conservation and subparagraphs 4.24.1 and 4.24.2 to require that all subdivisions be planned and designed to encourage energy conservation as follows:

"4.24 Energy Conservation: All subdivisions shall be planned and designed to encourage energy conservation as deemed necessary by the Planning Commission as follows:

4.24.1 by taking advantage of southerly exposures, proposed lots and development thereon shall have adequate solar access to the maximum extent possible.

4.24.2 proposed building locations and orientations required under subparagraph 3.2.8 shall be such that each dwelling has maximum solar access."

Proposed: 3/3/81
Revised: 4/7/81
Adopted: 6/2/81
Effective: 10/1/81

ADMINISTRATIVE POLICY #6 accompanying the Subdivision Regulations of the Town of Southbury, Connecticut

ENERGY CONSERVATION IN SUBDIVISIONS

A. General: Par. 4.24 Energy Conservation requires that all subdivisions will be planned and designed to encourage energy conservation by planning lots and development thereon to enable the use of solar energy systems to the maximum extent possible. The policies hereinafter set forth serve as a guide for the Commission and the applicant in planning and evaluating proposed subdivisions with regard to energy conservation.

B. Goals:

B-1. Maximum Possible Solar Access: New lots created by the act of subdivision should have adequate solar access to the maximum extent possible. "Adequate solar access to the maximum extent possible" should be interpreted to mean that all proposed lots have adequate solar access. The Commission realizes that not all lots will have sufficient solar access to make effective use of solar energy systems, whether passive or active, due to such factors as: a) the configuration or orientation of the tract; b) the nature of surrounding development; c) existing physical features of the tract such as topography, soils, vegetation; and d) road circulation patterns. However, in many instances, greater solar access can be achieved simply by considering solar access objectives at the initial planning stage. By providing the greatest possible degree of solar access on a lot, conservation purposes are served since the potential for immediate or future useage of solar energy is increased.

B-2. Use of Passive Solar Energy Systems: As many lots as possible should be capable of effectively using passive solar energy systems. This requires protection of the south-facing walls of the building from shadow-producing objects. If south wall access is protected, rooftop access is also guaranteed, enabling the use of active solar energy systems attached to the roof. It is not intended to require protection for south lot or detached collector access. (See Paragraph D-1 for definitions)

B-3. Solar Access Easements: Each lot should have control over its own south wall access to the maximum extent possible. The need for solar access easements on adjoining lots or other tracts of land should be minimized.

B-4. Individual Choice: By taking into account solar access requirements of proposed building lots in the planning stage, energy conservation will be encouraged by enabling the use of solar energy systems on as many lots as possible, should the owner so desire. However, it is not intended to require the use of solar energy systems on all buildings in new subdivisions. The choice is left to the individual lot owner.

C. Providing for Adequate Solar Access: As a guide in providing for the maximum solar access possible, the following factors should be considered:

C-1. Proposed Street Layout: Streets should have an east-west orientation whenever possible, with acceptable variations of 10° to the northwest and 25° to the southwest. Due to topographic or soil conditions, or existing street layouts, such an orientation may not be desirable or acceptable to the Planning Commission or the applicant since excessive grading or distrubance of wetlands would be required or an undesirable pattern of circulation result. Each subdivision must be reviewed individually as to conflicts between the provision of adequate solar access, the preservation of existing natural features on the tract, and desirable circulations patterns.

C-2. Lot Orientation: Lots should be arranged so as to take advantage of south-facing slopes on the tract. The longer axis of all minimum-sized lots should be oriented north-south whenever possible in order to minimize the shading of solar collectors from off-site development, vegetation or other natural features. On large lots, lot orientation may not be a critical factor, depending on other characteristics of the tract of land.

C-3. Building Location: Proposed development on the lots should enable the use of solar energy systems to the maximum extent possible by: a) locating buildings on south-facing slopes and as far north on the lot as possible in order to minimize the shading of solar collectors from on-site and off-site development, vegetation or other natural features; b) orienting buildings so that the longest axis is east to west. Such an orientation may result in house orientations which vary from the normal orientation whereby the longest house axis parallels the street. The Commission realizes that other orientations may be possible depending on architectural type and type of solar energy system, but that in most instances the stated orientation will achieve maximum solar access.

C-4. Sewage Disposal Location: Sewage disposal leaching fields should be located to the south of proposed house locations, unless soil conditions are not suitable or unless such a location would compel the use of an otherwise unnecessary pumped septic system. Such a location will aid the use of solar energy systems, since regrading and tree removal associated with the construction of leaching fields will reduce potential shading problems caused by existing vegetation.

C-5. Limits of Vegetation Control: In Southbury, most subdivisions are located on land that is at least partially forested. Therefore, one of the biggest problems in obtaining adequate solar access is the extent of tree removal and/or pruning necessary to keep the south wall of a dwelling free from shadows. It will not be necessary to cut down every tree to the south of a dwelling in order to obtain adequate solar access; trees further to the south may require only selective pruning. But the necessary area of tree removal and/or pruning may be quite large, depending on orientation and degree of slope, and may be too large to enable the effective use of solar energy systems without designating solar easements. As a guide in determining whether or not the use of solar energy systems is feasible on proposed lots without designating a solar easement, Par. 3.2.19 requires that the area of tree removal and/or pruning be shown on the site plan. The Planning Commission encourages the applicant to designate solar access easements whenever necessary. It is not intended, however, that any necessary tree removal be

done by the applicant or developer or that it be considered part of the work in the subdivision which is normally bonded.

C-6. Street Trees: The species and location of street trees should be selected to take into account solar access objectives. The size, length and intensity of shadows caused by street trees depends on such things as mature height, mature canopy size, the opacity of the tree without its leaves, and the times of the year when new leaves come out and old leaves fall. The species of street trees selected should take into account those shadow-producing characteristics so that the adverse effects of street trees on the solar access of surrounding development will be minimized.

C-7. Open Space in Subdivisions: Par. 4.18 Open Spaces, Park and Playgrounds requires that at least 10% of the total area of subdivisions be reserved for open space, park or playground purposes. In certain instances, the location of such reservation can aid energy conservation purposes.

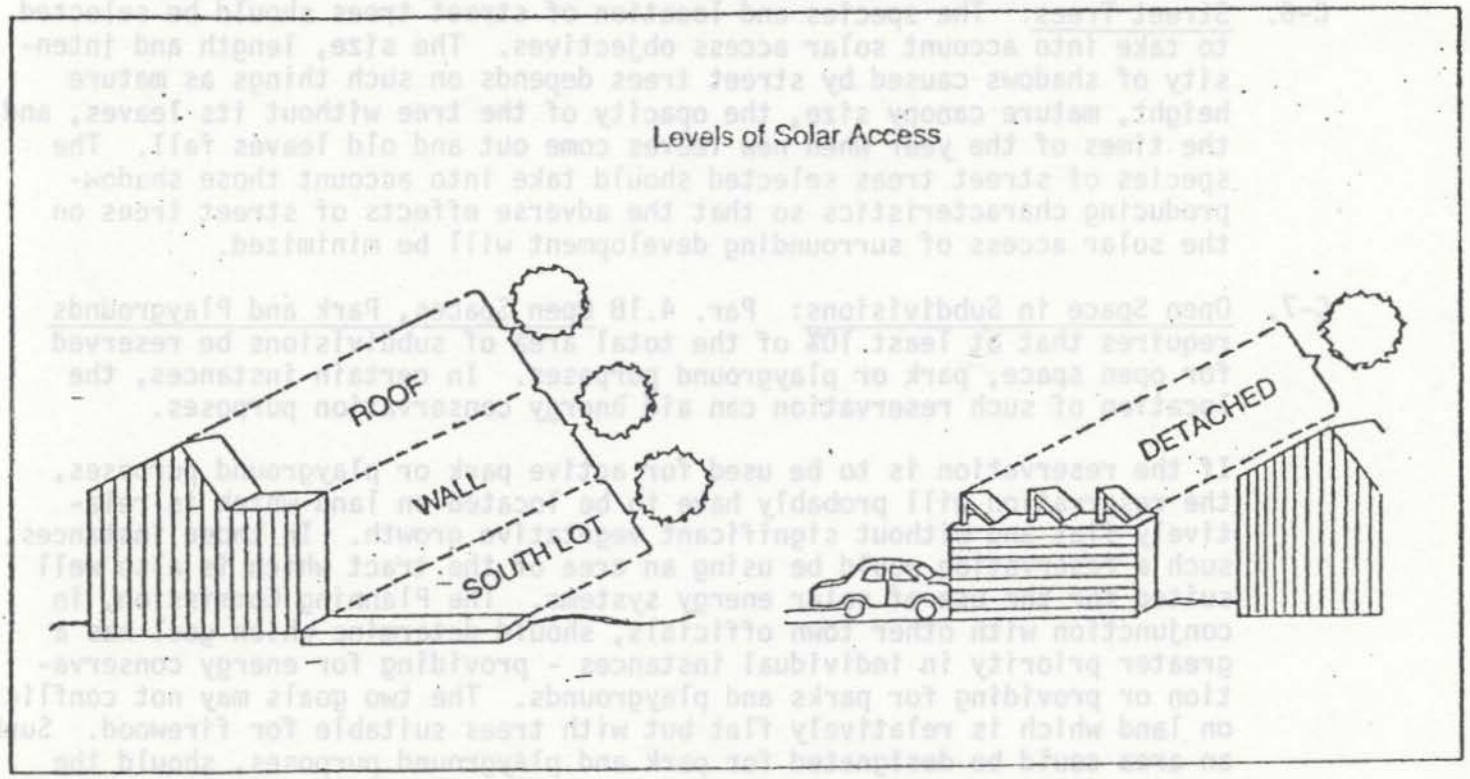
If the reservation is to be used for active park or playground purposes, the reservation will probably have to be located on land which is relatively flat and without significant vegetative growth. In those instances, such a reservation would be using an area of the tract which is also well suited for the use of solar energy systems. The Planning Commission, in conjunction with other town officials, should determine which goal has a greater priority in individual instances - providing for energy conservation or providing for parks and playgrounds. The two goals may not conflict on land which is relatively flat but with trees suitable for firewood. Such an area could be designated for park and playground purposes, should the town be willing to use the parcel as a community woodlot first.

If the reservation is to be used for open space purposes, its location can serve energy conservation in two different ways. First, open space which is reserved on steep northerly slopes with a substantial tree cover can prevent the creation of lots with inadequate solar access. Even if the open space reservation is a conservation restriction on one or more proposed lots, it should be located so that building is restricted from areas with inadequate solar access. Secondly, open space land can serve as a location for community solar systems. In those instances when few proposed lots have adequate solar access, the open space land should be located on a portion of the tract which does have adequate solar access whenever possible in order to provide for the present and future use of community solar energy systems. When such a reservation is made, the conveyance of said land should state that the use of community solar energy systems is a permitted use on said land.

C-8. Conflicts with other design standards: Measures for providing for adequate solar access may conflict with other design standards. For example, a street layout which fosters good solar access may not provide a suitable circulation pattern or may have unacceptable effects on the environment. The applicant should choose those alternatives which appear most acceptable to him; however, the Planning Commission will make the final determination regarding suitable resolutions of such conflicts.

D. The Basics of Solar Access: As an aid in determining whether or not proposed lots have adequate solar access, the following information should be used:

D-1. Levels of Solar Access: There are four types of solar access: rooftop, south-wall, south-lot and detached collector access. Each type refers to the location of the solar collector and is shown in the figure below:



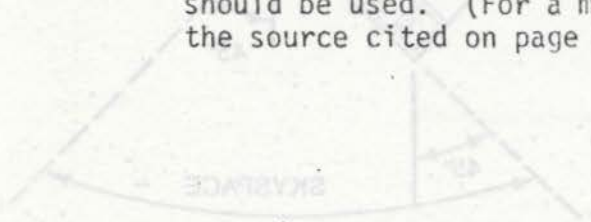
Source: "Site Planning for Solar Access, A Guidebook for Residential Developers and Site Planners", published by the U. S. Department of Housing and Urban Development, Contract Number: H-2573 and prepared by the American Planning Association.

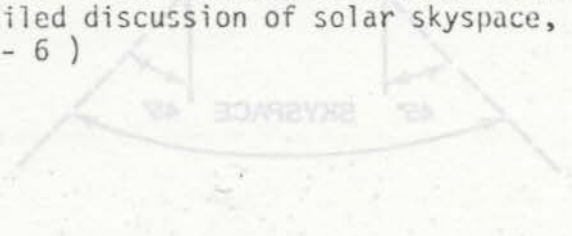
D-2. Shadow Lengths: The length of a shadow cast by an object depends on the following characteristics of the land on which the object is located: a) orientation of slope, b) degree of slope, and c) time of day. For determining shadow lengths in the Town of Southbury, Table A (attached) should be used.

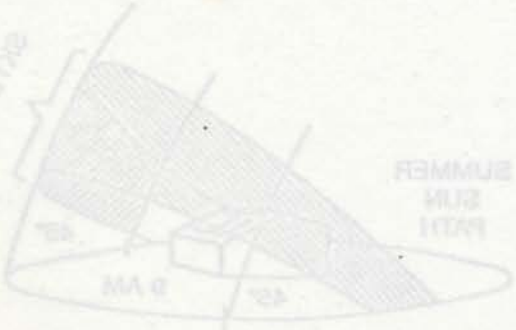
To calculate the shadow length of an object, multiply the height of the object by the factor in the table. For example, a tree which is 50 feet tall, located on a 10% slope priented to the east, will produce a shadow 200 feet long at 9:00 A.M., 110 feet long at noon, and 470 feet long at 3:00 P.M.

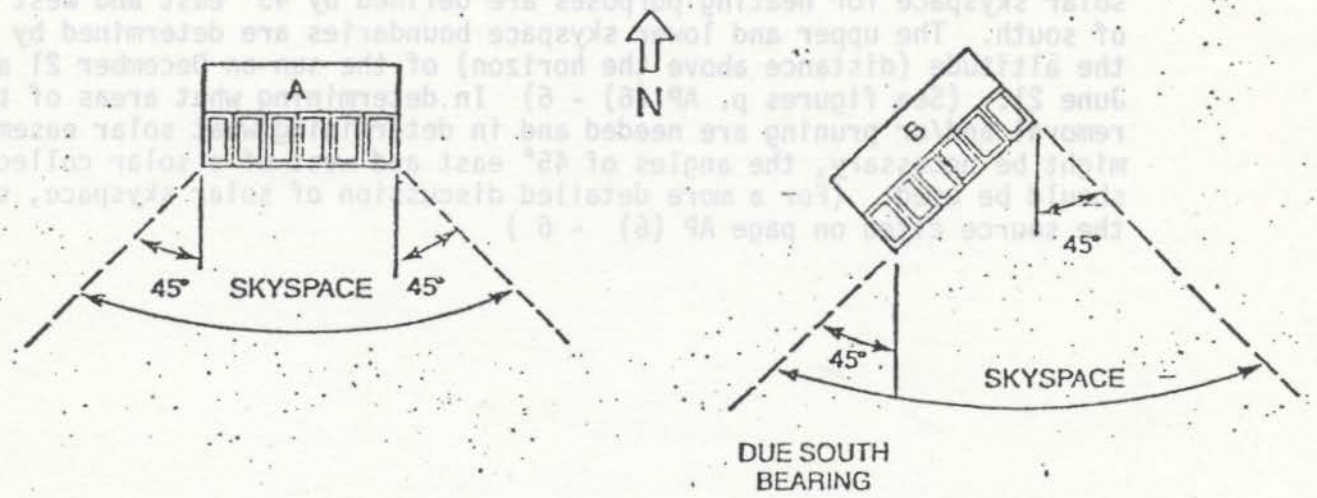
D-3. Solar Skyspace: It is not necessary for a solar collector to be unobstructed by shadows from sunrise to sunset. That portion of the sky which must remain unobstructed for a solar collector to operate efficiently is defined as skyspace and is partially determined by the sun's position on December 21, the day of the year when shadows are longest. Approximately 86% of the sun's energy is received between the hours of 9:00 A.M. and 3:00 P.M. at north latitude 40° on December 21. (Southbury's north latitude is approximately 41°30') On that date at 9:00 A.M. the sun is located 45° east of

south and at 3:00 P.M. the sun is located 45° west of south, measured on the horizon. Therefore, the eastern and western boundaries of the solar skyspace for heating purposes are defined by 45° east and west of south. The upper and lower skyspace boundaries are determined by the altitude (distance above the horizon) of the sun on December 21 and June 21. (See figures p. AP (6) - 6) In determining what areas of tree removal and/or pruning are needed and in determining what solar easements might be necessary, the angles of 45° east and west of a solar collector should be used. (For a more detailed discussion of solar skyspace, see the source cited on page AP (6) - 6)

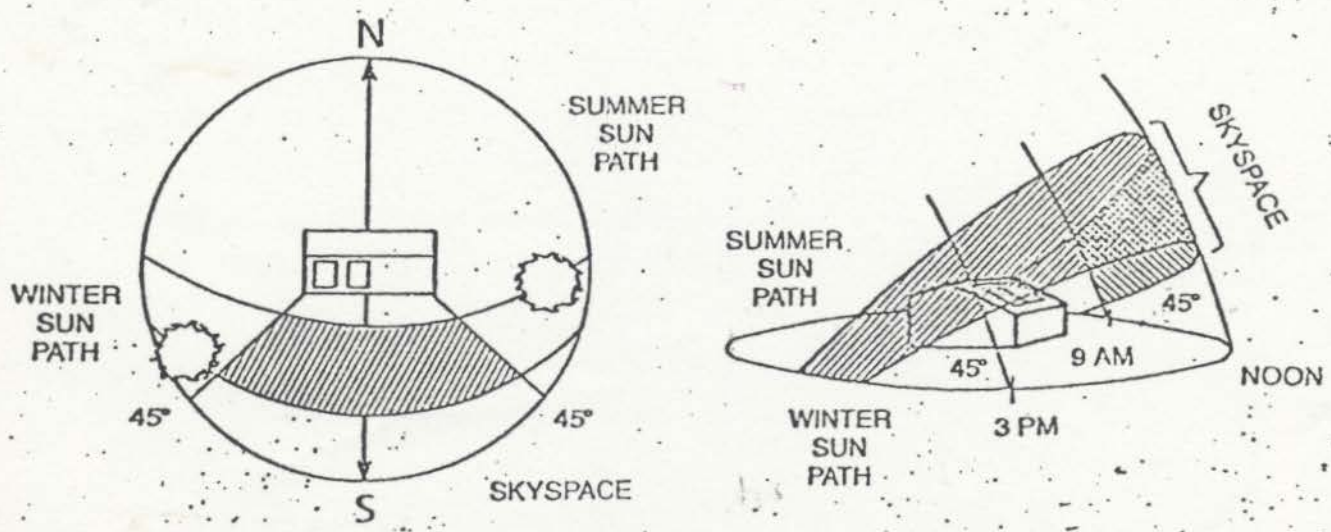








Solar Skyspace (Plan and Isometric Views)



Source: "Site Planning for Solar Access, A Guidebook for Residential Developers and Site Planners", published by the U.S. Department of Housing and Urban Development, Contract Number: H-2573 and prepared by the American Planning Association.

TABLE A: Shadow Length Table for the Central Naugatuck Valley Region

Latitude 41° 30

	N			NE			E			SE			S			SW			W			NW		
Slope	A.M.	NOON	P.M.	A.M.	NOON	P.M.	A.M.	NOON	P.M.	A.M.	NOON	P.M.	A.M.	NOON	P.M.	A.M.	NOON	P.M.	A.M.	NOON	P.M.	A.M.	NOON	P.M.
0%	5.34	2.14	5.34	5.34	2.14	5.34	5.34	2.14	5.34	5.34	2.14	5.34	5.34	2.14	5.34	5.34	2.14	5.34	5.34	2.14	5.34	5.34	2.14	5.34
5%	6.59	2.40	6.59	5.34	2.32	7.29	4.49	2.14	6.59	4.21	1.99	5.34	4.49	1.93	4.49	5.34	1.99	4.21	6.59	2.14	4.49	7.29	2.32	5.34
10%	8.59	2.72	8.59	5.34	2.52	11.47	3.88	2.14	8.59	3.48	1.86	5.34	3.88	1.76	3.88	5.34	1.86	3.48	8.59	2.14	3.88	11.47	2.52	5.34
15%	12.33	3.15	12.33	5.34	2.77	26.88	3.41	2.14	12.33	2.97	1.74	5.34	3.41	1.62	3.41	5.34	1.74	2.97	12.33	2.14	3.41	26.88	2.77	5.34
20%	21.85	3.74	21.85	5.34	3.07	**	3.04	2.14	21.85	2.58	1.64	5.34	3.04	1.50	3.04	5.34	1.64	2.58	21.85	2.14	3.04	**	3.07	5.34
25%	95.95	4.60	95.95	5.34	3.44	**	2.75	2.14	95.95	2.29	1.55	5.34	2.75	1.39	2.75	5.34	1.55	2.29	95.95	2.14	2.75	**	3.44	5.34

Source: CNVRPA Staff work based on a shadow length formula contained in Appendix I of Protecting Solar Access for Residential Development: A Guidebook for Planning Officials, American Planning Association, 1979

Note: The a.m. time refers to 8:33 local standard time (LST) the p.m. time refers to 3:08 local standard time (LST) and the noon time refers to 11:51 a.m. The a.m. and p.m. times correspond to 45 degree azimuths that are used to define the day's period of usable radiation. About 86% of the total available sunshine on December 21st falls between the hours of 8:33 a.m. and 3:08 p.m. The table gives the shadow length on December 21st of a one (1) foot pole for varying slopes and orientations. Approximate shadow lengths for slopes not listed in the table may be interpolated. However, for more accurate measurements the following formula may be used in lieu of the table:

$$SP = \frac{H}{\tan (A_1) * S_1 \times \cos (A_z - w)}$$

Where: A_1 = solar altitude (25.05° = Altitude at (11,51 a.m. LST) (10,60°=Altitude at 8:33 a.m. & 3:08 p.m. LST)
A_z = solar azimuth (a.m. or p.m. =45°, noon=0°)
H = height of the object (The table assumes an object one foot tall)
W = orientation (0 =south 90° = west - 90° = East, 180° = North etc)
S_1 = slope (in percent)

**Afternoon shadow lengths on Northeast slopes of 20% or greater and morning shadow lengths on Northeast slopes of 20% or greater do not offer any solar access opportunities.

CITY OF ALBUQERQUE, NEW MEXICO

COUNCIL BILL NO. O-32 ENACTMENT NO. 62-1970

SPONSORED BY: Marion M. Cottrell
Robert M. White
Fran J. Hill

ORDINANCE

AMENDING ARTICLE XIV OF CHAPTER 7 OF THE REVISED ORDINANCES OF ALBUQUERQUE, NEW MEXICO, 1974, THE COMPREHENSIVE CITY ZONING CODE, RELATING TO SOLAR ACCESS.

BE IT ORDAINED BY THE COUNCIL, THE GOVERNING BODY OF THE CITY OF ALBUQUERQUE:

Section 1. Section 2.A of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended to read as follows:

"A. This ordinance is intended to help achieve Article IX of the Charter of the City of Albuquerque and the city's master plan, in particular the master plan documents which comprise the Albuquerque/Bernalillo County Comprehensive Plan. This ordinance is intended to create orderly, harmonious, and economically sound development in order to promote the health, safety, convenience, and general welfare of the citizens of the city. These regulations are necessary to provide adequate open spaces for light and air including solar access; to avoid undue concentration of population, to secure safety from fire, panic, and other dangers; to help control congestion in the streets and public ways; to control and abate unsightly use of buildings or land; to facilitate adequate provisions for community utilities and facilities such as transportation, water, sewer, schools, and parks; to encourage the most appropriate use of land; to properly channel flood water runoff; to conserve and stabilize the value of property; and to enhance the appearance of the landscape."

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Section 2. Section 5.B. of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended by inserting a new subsection to read as follows:

"58. "NORTHERN BOUNDARY" means the lot line lying generally to the north side of a lot which is the most nearly perpendicular to cardinal north."

Renumber existing paragraphs 5.B 58 through 111 as 59 through 112 respectively.

Section 3. Sections 5.B.74 and 5.B.92, of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, are hereby amended to read as follows:

A. 5.B.75: (Previously 5.B.74):

75. "SECTOR DEVELOPMENT PLAN" means a plan, at a scale of 1 inch to 200 feet or 1 inch to 400 feet, which covers a large area satisfactory to the Planning Commission and specifies standards for the area's and subarea's character, allowed uses, structure height, and dwelling units per acre; the plan may specify lot coverage, floor area ratio, major landscaping features, building massing, flood water management, parking, signs, provisions for maximum feasible solar access, provisions for transportation and other features. Such plan constitutes a detailed part of the master plan and must be essentially consistent with the more general elements of the master plan: The Albuquerque/Bernalillo County Comprehensive Plan.

B. 5.B.93: (Previously 5.B.92):

93. "SITE DEVELOPMENT PLAN" means an accurate plan at a scale of at least 1 inch to 100 feet which covers at least one lot and specifies the site, proposed use, exact structure locations, structure (including sign) elevations and dimensions, pedestrian and vehicular circulation, parking facilities, loading facilities any energy conservation features in the plan (e.g. appropriate landscaping, building heights and siting for solar access, provision for non-auto transportation, or energy conservational building construction), and proposed schedule for development. Similar, related data may be required when relevant to the

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City's evaluation."

Section 4. Section 10.D of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended to read as follows:

"Lot size. Minimum lot area shall be 6,000 square feet. Minimum lot width shall be 60 feet, except that on all streets oriented north and south or within 30 degrees of this axis, minimum lot width in subdivisions for which plats are submitted after February 1, 1981, shall be 65 feet. Provided, however, that the 65 foot lot width requirement shall not apply if there are other means of assuring solar access to the lot, or the nature of the existing or approved future development contiguous to the lot precludes solar access to it."

Section 5. Section 10.E of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended by inserting a new subsection to read as follows:

"3.d For lots in subdivisions for which plats are submitted after November 1, 1980 and which front on streets which are oriented due North-South or within 30 degrees from this orientation, the minimum side yard setback on the southerly side shall be either:

(1) 15 feet if the immediately adjacent side yard setback is 5 feet or less, or

(2) 10 feet if the immediately adjacent side yard setback is 5 feet or more.

In no case shall the distance between two residential buildings be less than 15 feet.

Setback lines shall be as indicated on the final plat (by note, reference or dimension) or as recited in the Restrictive Covenants filed with the plat. In absence of the above, the setbacks shall be herein defined and the minimum side setback for lots within the provisions of Section 10.E.3.d shall be 10 feet on the South side and 5 feet on the North side of each lot, except that on a corner lot the side yard setback on the street side must be at least 10 feet."

Section 6. Section 40.C.1.b of Article XIV of Chapter 7 of the

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Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended to read as follows:

"b. A height variance may be approved for the following structures even though there is only a minimal showing as to exceptional physical condition:

(1) Chimneys

(2) Conveyers

(3) Cooling towers

(4) Cupolas and domes

(5) Elevator housings

(6) Mechanical equipment and its screening

(7) Observation towers

(8) Penthouses

(9) Smoke enclosures

(10) Smoke stacks

(11) Solar Collection

(12) Stage Towers or Scenery Lofts

(13) Tanks

(14) Water tanks

Section 7. Section 40.C.1 of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended by adding a new subsection c to read as follows:

"c. A setback variance may be approved for the following structures even though there is only a minimal showing as to exceptional physical condition: solar collectors.

Reletter existing subsections 40.C.1. c, d, and e as d, e and f respectively."

Section 8. Section 40.C.1. of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended by adding a new subsection g to read as follows:

"g. Building Height Limitations to Preserve Solar Access.

The additional height limitations of this subsection shall apply to all residential zones where the basic height limitation is 26

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feet. In any subdivision for which the preliminary or preliminary/final plat is submitted to the City after February 1, 1981, the height of any building shall comply with one of the following additional height limitations, either:

(1) The building height shall not exceed the following heights, determined by the distance cardinally south from the northern boundary of the lot as follows:

Distance Cardinally South From Northern Lot Line	Height
0-5 feet	8 feet except 10 feet for townhouses with a party wall at the subject lot line
5-10 feet	10 feet
10-15 feet	13 feet
15-20 feet	15 feet
20-25 feet	17 feet
25-30 feet	19 feet
30-35 feet	21 feet
35-40 feet	23 feet
40-45 feet	25 feet or alternatively

(2) The height shall not exceed a 23-degree-angle plane (as further defined in paragraph (c) below) drawn upward from a horizontal line located two feet above the mean grade at either:

(a) A line lying ten feet within the lot lying to the north and parallel to the general south side of the neighboring lot which is most nearly perpendicular to cardinal north, if the lot is vacant and no building permit for a structure has been applied for; or

(b) The facade of the principal residential building on the lot lying to the north, which most nearly faces cardinal south if the lot has an existing building intended for permanent occupancy or a building permit for such a structure has been issued.

(c) The plane shall be made up of lines drawn cardinally south, 23 degrees above horizontal, along all points identifying said southerly setback lines or building lines.

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(3) The Zoning Enforcement Officer shall waive all or part of the provisions of paragraphs (1) and (2) above if he finds that, pursuant to rules and regulations promulgated by the Mayor and so records in his files, benefical and important solar access can be protected for a lot to the north through the height requirements of this subsection due to:

(a) The lot(s) to the north being exceptionally large or high, so that there are many good locations for solar collectors relating to passive or active solar energy systems which will not be blocked by the proposed construction; or

(b) The development on the lot(s) to the north is already served by as much solar collector area as is likely to ever be needed and solar access to that collector surface will not be impaired by the proposed construction."

Section 9. Section 40.C.2.b (1) of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended to read as follows:

"(1) Unless approved under a Site Development Plan, an accessory building on a lot the principal use of which is a house or town house shall not be located in the required front yard setback and shall not occupy over 25 percent of the side-plus-rear-yards. An accessory structure in any required yard shall not exceed either 13 feet in height, or any applicable height limitations imposed by 1.g of this subsection, except if it is in a required side yard setback on a corner, it shall not exceed the height of the fence allowed by 1.d of this subsection."

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Section 10. Section 5.B.35 of Article XIV of Chapter 7 of the Revised Ordinances of Albuquerque, New Mexico, 1974, is hereby amended by inserting a new subsection to read as follows:

"35. " HEIGHT," when applied to a building, means the vertical distance above grade to the highest point of the coping of a flat roof or to the deck line of mansard roof or to the average height between the plate and ridge of a gable, hip, or gambrel roof. The height of a stepped or terraced building is the maximum height of any segment of the building. (This definition applies to height regulations found in a specific zones but not to regulations found in the General Regulations, Section 40.C.)"

Severability Clause. If any section, subsection, sentence, clause, word or phrase of this ordinance is for any reason held to be unconstitutional or other wise invalid by any court of competent jurisdiction, such decision shall not affect the validity of the remaining portions of this ordinance. The Council, the Governing Body of the City of Albuquerque, hereby declares that it would have passed this ordinance and each section, subsection, sentence, clause, word, or phrase thereof irrespective of any one or more sections, subsections, sentences, clauses, words or phrases being declared unconstitutional or otherwise invalid.

Section 11. Compiling Clause. This ordinance shall be incorporated in and compiled as a part of the Revised Ordinances of Albuquerque, New Mexico, 1974.

Section 12. Effective Date and Publication. This ordinance shall become effective five days after publication in full.

adopted 6/30/80

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Substitute House Bill No. 6764

PUBLIC ACT NO. 81-334

AN ACT CONCERNING PASSIVE SOLAR DESIGN FOR SUBDIVISIONS.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1. Section 8-25 of the general statutes is repealed and the following is substituted in lieu thereof:

(a) No subdivision of land shall be made until a plan for such subdivision has been approved by the commission. Any person, firm or corporation making any subdivision of land without the approval of the commission shall be fined not more than five hundred dollars for each lot sold or offered for sale or so subdivided. Any plan for subdivision shall, upon approval, or when taken as approved by reason of the failure of the commission to act, be filed or recorded by the applicant in the office of the town clerk within ninety days of the date such plan is delivered to the applicant, but, if it is a plan for subdivision wholly or partially within a district, it shall be filed in the offices of both the district clerk and the town clerk, and any plan, not so filed or recorded within the prescribed time shall become null and void, except that the commission may extend the time for such filing for two additional periods of ninety days and the plan shall remain valid until the expiration of such extended time. All such plans shall be delivered to the applicant for filing or recording promptly after the time for taking an appeal from the action of the commission has elapsed, and in the event of an appeal, promptly upon the termination of such appeal by dismissal, withdrawal or judgment in favor of the applicant. No such plan shall be recorded or filed by the town clerk or district clerk or other officer authorized to record or file plans until its approval has been endorsed thereon by the chairman or secretary of the commission, and the filing or recording of a subdivision plan without such approval shall be void. Before exercising the powers granted in this section, the commission shall adopt regulations covering the subdivision of land. No such regulations shall become effective until after a public hearing, notice of the time, place and purpose of which shall be given by publication in a newspaper of general circulation in the municipality at least twice, at intervals of not

less than two days, the first not more than fifteen days nor less than ten days, and the last not less than two days prior to the date of such hearing. Such regulations shall provide that the land to be subdivided shall be of such character that it can be used for building purposes without danger to health or the public safety, that proper provision shall be made for water, drainage and sewerage and, in areas contiguous to brooks, rivers or other bodies of water subject to flooding, including tidal flooding, that proper provision shall be made for protective flood control measures and that the proposed streets are in harmony with existing or proposed principal thoroughfares shown in the plan of development as described in section 8-23, especially in regard to safe intersections with such thoroughfares, and so arranged and of such width, as to provide an adequate and convenient system for present and prospective traffic needs. Such regulations shall also provide that the commission may require the provision of open spaces, parks and playgrounds when, and in places, deemed proper by the planning commission, which open spaces, parks and playgrounds shall be shown on the subdivision plan. Such regulations may provide that proper provision be made for sedimentation control, and the control of erosion caused by wind or water. [Such regulations may also encourage energy-efficient patterns of development, the use of solar and other renewable forms of energy, and energy conservation.] The commission may also prescribe the extent to which and the manner in which streets shall be graded and improved and public utilities and services provided and, in lieu of the completion of such work and installations previous to the final approval of a plan, the commission may accept a bond in an amount and with surety and conditions satisfactory to it securing to the municipality the actual construction, maintenance and installation of such improvements and utilities within a period specified in the bond. Such regulations may provide, in lieu of the completion of the work and installations above referred to, previous to the final approval of a plan, for an assessment or other method whereby the municipality is put in an assured position to do such work and make such installations at the expense of the owners of the property within the subdivision.

(b) THE REGULATIONS ADOPTED UNDER SUBSECTION (a) OF THIS SECTION MAY ALSO ENCOURAGE ENERGY-EFFICIENT PATTERNS OF DEVELOPMENT AND LAND USE, THE USE OF SOLAR AND OTHER RENEWABLE FORMS OF ENERGY, AND ENERGY CONSERVATION. THE REGULATIONS SHALL REQUIRE ANY PERSON SUBMITTING A PLAN FOR A SUBDIVISION TO THE COMMISSION UNDER SUBSECTION (a) OF THIS SECTION TO DEMONSTRATE TO THE COMMISSION THAT HE HAS CONSIDERED, IN DEVELOPING THE PLAN, USING PASSIVE SOLAR ENERGY TECHNIQUES WHICH WOULD NOT SIGNIFICANTLY INCREASE THE COST OF THE HOUSING TO THE BUYER, AFTER TAX CREDITS, SUBSIDIES AND EXEMPTIONS. AS USED IN THIS SUBSECTION AND SECTION 8-2, AS AMENDED BY SECTION 2 OF THIS ACT, PASSIVE SOLAR ENERGY TECHNIQUES MEAN SITE DESIGN TECHNIQUES WHICH MAXIMIZE SOLAR HEAT GAIN, MINIMIZE HEAT LOSS AND PROVIDE THERMAL STORAGE WITHIN A BUILDING DURING THE HEATING SEASON AND MINIMIZE HEAT GAIN AND PROVIDE FOR NATURAL VENTILATION DURING THE COOLING SEASON. THE SITE DESIGN TECHNIQUES SHALL INCLUDE, BUT NOT BE LIMITED TO: (1) HOUSE ORIENTATION; (2) STREET AND LOT LAYOUT; (3) VEGETATION; (4) NATURAL AND MAN-MADE TOPOGRAPHICAL FEATURES; AND (5) PROTECTION OF SOLAR ACCESS WITHIN THE DEVELOPMENT.

Sec. 2. Section 8-2 of the general statutes is repealed and the following is substituted in lieu thereof:

The zoning commission of each city, town or borough is authorized to regulate, within the limits of such municipality, the height, number of stories and size of buildings and other structures; the percentage of the area of the lot that may be occupied; the size of yards, courts and other open spaces; the density of population and the location and use of buildings, structures and land for trade, industry, residence or other purposes, and the height, size and location of advertising signs and billboards. Such zoning commission may divide the municipality into districts of such number, shape and area as may be best suited to carry out the purposes of this chapter; and, within such districts, it may regulate the erection, construction, reconstruction, alteration or use of buildings or structures and the use of land. All such regulations shall be uniform for each class or kind of buildings, structures or use of land throughout each district, but the regulations in one district may differ from those in another district, and may provide that certain classes or

kinds of buildings, structures or use of land are permitted only after obtaining a special permit or special exception from a zoning commission, planning commission, combined planning and zoning commission or zoning board of appeals, whichever commission or board the regulations may, notwithstanding any special act to the contrary, designate, subject to standards set forth in the regulations and to conditions necessary to protect the public health, safety, convenience and property values. Such regulations shall be made in accordance with a comprehensive plan and shall be designed to lessen congestion in the streets; to secure safety from fire, panic, flood and other dangers; to promote health and the general welfare; to provide adequate light and air; to prevent the overcrowding of land; to avoid undue concentration of population and to facilitate the adequate provision for transportation, water, sewerage, schools, parks and other public requirements. Such regulations shall be made with reasonable consideration as to the character of the district and its peculiar suitability for particular uses and with a view to conserving the value of buildings and encouraging the most appropriate use of land throughout such municipality. Zoning regulations may be made with reasonable consideration for the protection of historic factors and for the protection of existing and potential public surface and ground drinking water supplies and may provide that proper provision be made for sedimentation control, and the control of erosion caused by wind or water. Such regulations may also encourage energy-efficient patterns of development, the use of solar and other renewable forms of energy, and energy conservation. THE REGULATIONS MAY ALSO PROVIDE FOR INCENTIVES FOR DEVELOPERS WHO USE PASSIVE SOLAR ENERGY TECHNIQUES, AS DEFINED IN SUBSECTION (b) OF SECTION 8-25, AS AMENDED BY SECTION 1 OF THIS ACT, IN PLANNING A RESIDENTIAL SUBDIVISION DEVELOPMENT. THE INCENTIVES MAY INCLUDE, BUT NOT BE LIMITED TO, CLUSTER DEVELOPMENT, HIGHER DENSITY DEVELOPMENT AND PERFORMANCE STANDARDS FOR ROADS, SIDEWALKS AND UNDERGROUND FACILITIES IN THE SUBDIVISION. Such regulations shall not prohibit the continuance of any nonconforming use, building or structure existing at the time of the adoption of such regulations. Any city, town or borough which adopts the provisions of this chapter may, by vote

of its legislative body, exempt municipal property from the regulations prescribed by the zoning commission of such city, town or borough; but unless it is so voted municipal property shall be subject to such regulations.

Certified as correct by

_____
Legislative Commissioner.

_____
Clerk of the Senate.

_____
Clerk of the House.

Approved _____, 1981

_____
Governor.

B I B L I O G R A P H Y

LAND PLANNING AND DESIGN STUDIES ON SOLAR ENERGY AND SOLAR ACCESS

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